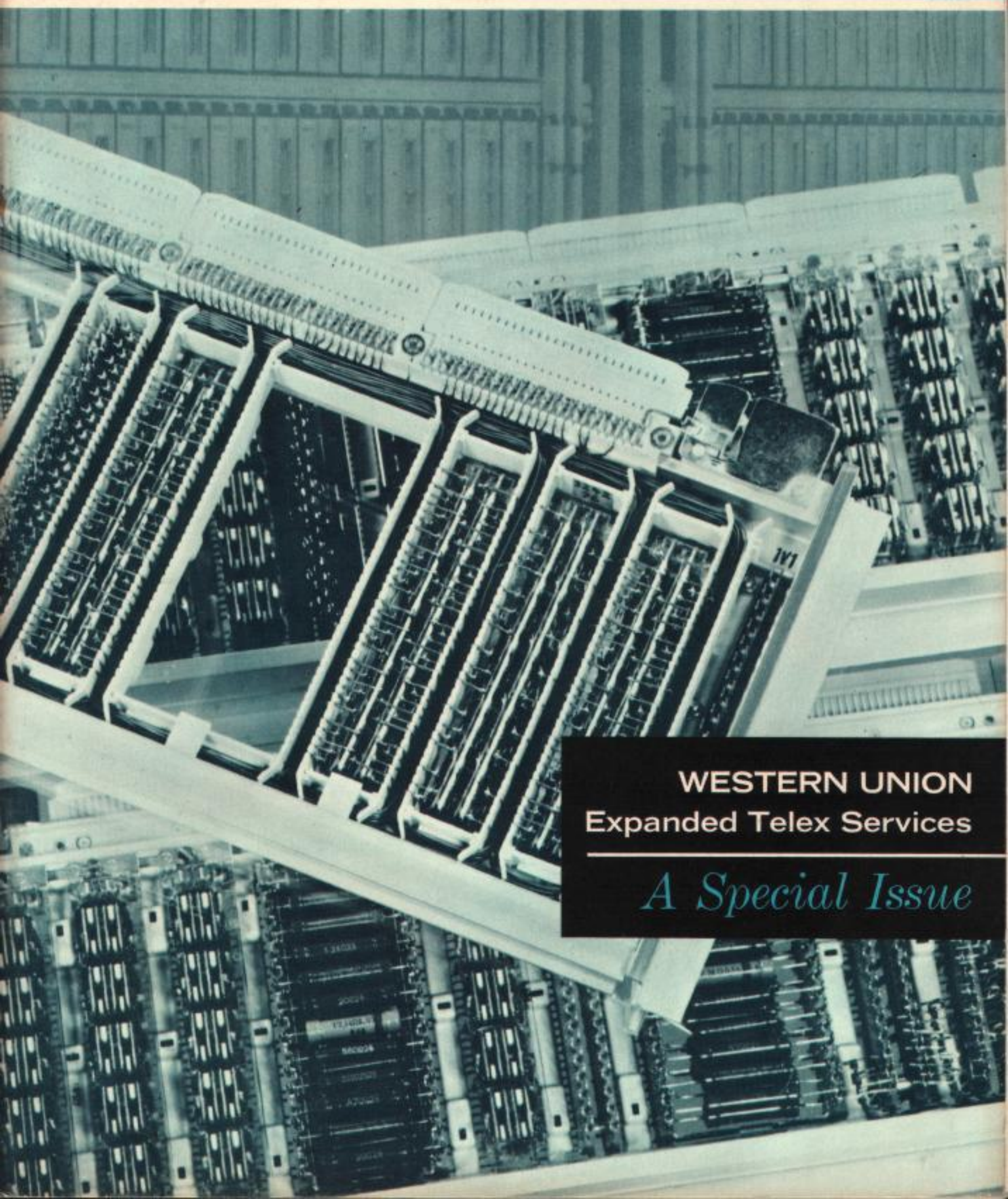




Technical Review

VOLUME 20 NO. 3

JULY 1966



WESTERN UNION
Expanded Telex Services

A Special Issue



The purpose of the TECHNICAL REVIEW is to present technological advances and their applications to communications.

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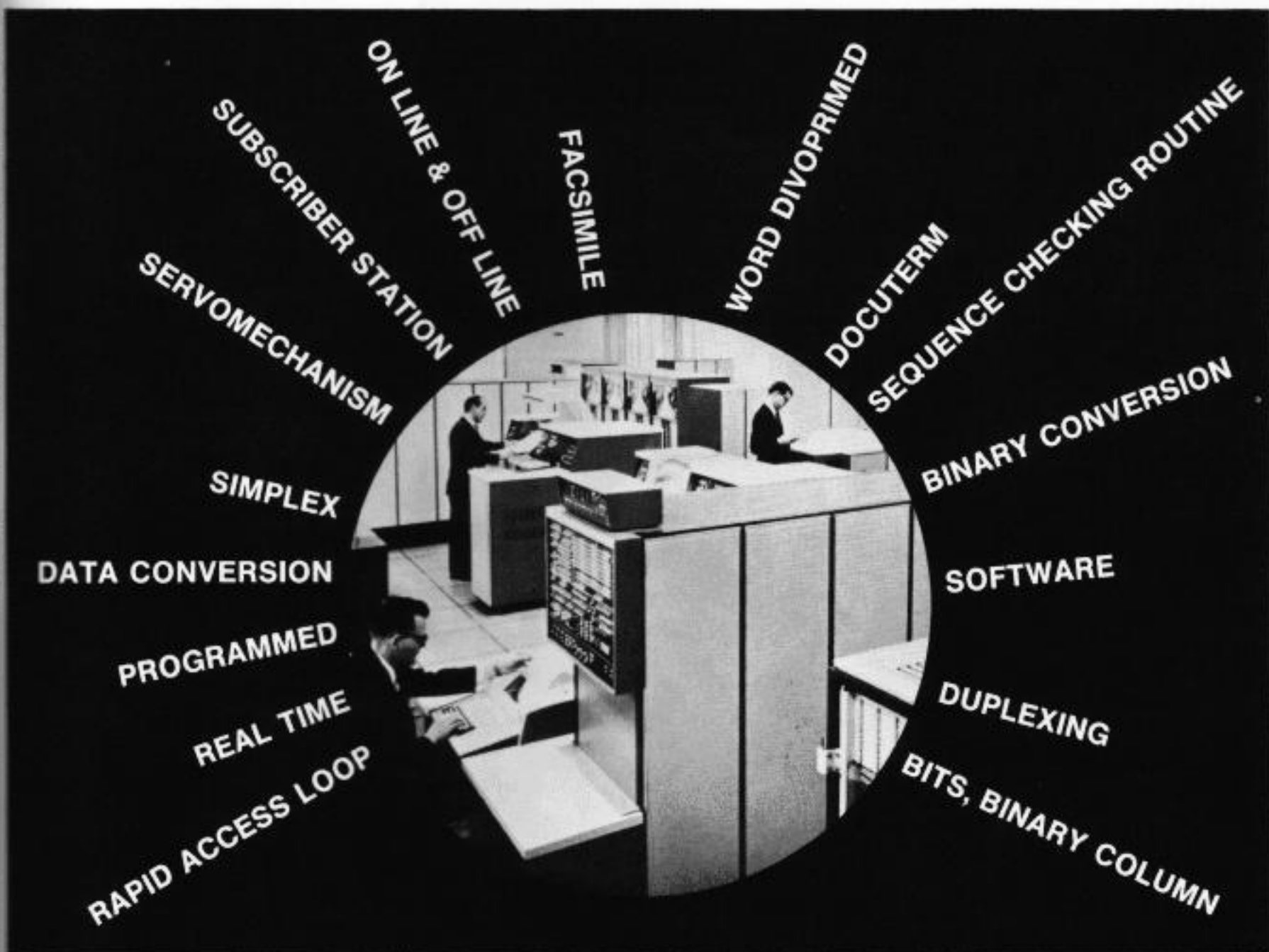
Western Union

60 Hudson St.

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The TECHNICAL REVIEW is published by the Information Systems and Services Department for management, supervisory and technical personnel in Western Union. It is issued quarterly in January, April, July and October.

Subscription Rates:	United States	— \$2.00 per year
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Single Copies:	United States	— 50¢ plus handling charge
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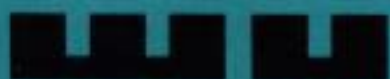
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volume 20 number 3

july 1966

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Cover: Artist rendition of ESK relay strip used in modular construction for the TWK Telex subscribers.

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Telex

The Bridge

to

World

International communications has exhibited tremendous strides forward in the past 20 years. The importance of record communications is constantly increasing because of the difficulties of voice language barriers in the international field.

Telex has provided a common media for record communications among the nations of Europe. The International Consultative Committee, CCITT, is an international body which determines the standard signalling techniques and the operating criteria which shall be used among nations. This world body has modified its standards to keep pace with the ever changing nature of the communications technology. Therefore, it is natural that the Telex service should follow or adhere to these universally accepted techniques. This service necessarily grows as the world's need for record communication grows.

Today, Western Union Telex subscribers in the United States can dial directly other Telex subscribers in Europe. They can also contact Telex subscribers around the world via semi-automatic means. GENTEX, international cablegrams, sent from cities in West Germany to cities in the United States, are

Communications



J. H. Weems, Jr.

transmitted via Telex. International cablegrams from cities in the United States can be transmitted via Telex to the international common carriers. Besides these, a fully integrated Telex system is provided between the United States, Mexican, and Canadian subscribers. Western Union is involved in all the above services.

Thus, it may be concluded that some of the present record communication modes, as well as those anticipated future modes, will help bridge world communications. Telex is often referred to as the BRIDGE TO WORLD COMMUNICATIONS.

J. H. Weems, Jr.



planning western union's telex system

—Kenneth M. Jockers

The growth and acceptance of the Western Union Telex Network is a demonstration of the continuing and increasing needs for record communications in American business. In 1958 Western Union Telex started in New York¹ as a satellite of the then existing Canadian Telex network. The equipment chosen for this first experimental offering was a Siemens' TW39, the same equipment used in Canada. Since the Canadian network, at this time, had over a thousand subscribers, it was obvious that the Western Union System, started in New York, would be very popular.

The immediate acceptance of the service in New York led to the installation of other exchange types in Chicago and San Francisco. Soon afterwards Los Angeles was added to the complex.

Up to this point Western Union's plans for further growth were based on the technical experience of the Canadian system and its principal equipment supplier, Siemens. Various types of equipment were installed in four cities. It soon became apparent that the responsibility for stipulating future equipment types and systems' development would necessarily be that of Western Union's engineering department.

Technical Considerations

The service now offered by Western Union Telex is basically a 50 baud, teleprinter exchange service using standard CCITT codes. The transmission is digital, either makebreak or polar from sub-

scribers. On all trunks polar signals are transmitted utilizing space division Type 60 or 65 carrier. The exchanges are not limited to code and the minimum bit rate limitation is 5 ms. The Type 60 or 65 carrier makes the system limited to a minimum bit rate of 20 ms, and a maximum of six tandem sections. Under this arrangement no regeneration is required.

The billing of Telex subscribers is based on time and distance and is recorded as a bulk charge on a counter associated with each subscriber. The time and distance is obtained by translating the dialed digits into a pulse rate, which is then applied to the subscriber's counter. This technique of billing is simple and economical.

Phase I

The first phase in the planning of the three level Telex network featured the equipment tried at New York, Chicago, San Francisco and Los Angeles. The first level, junction office level, used TWM2 equipment, and all first level offices were fully interconnected. In order to improve trunk utilization, automatic alternate routing was provided to meet our requirement in TWM2 equipment. The second level, district office level, incorporated TW39 equipment, and concentrated its tandem traffic on one trunk bundle to its parent exchange. The TW56 concentrator and also TW39 equipment is used in the third level, sub-district office level, to con-

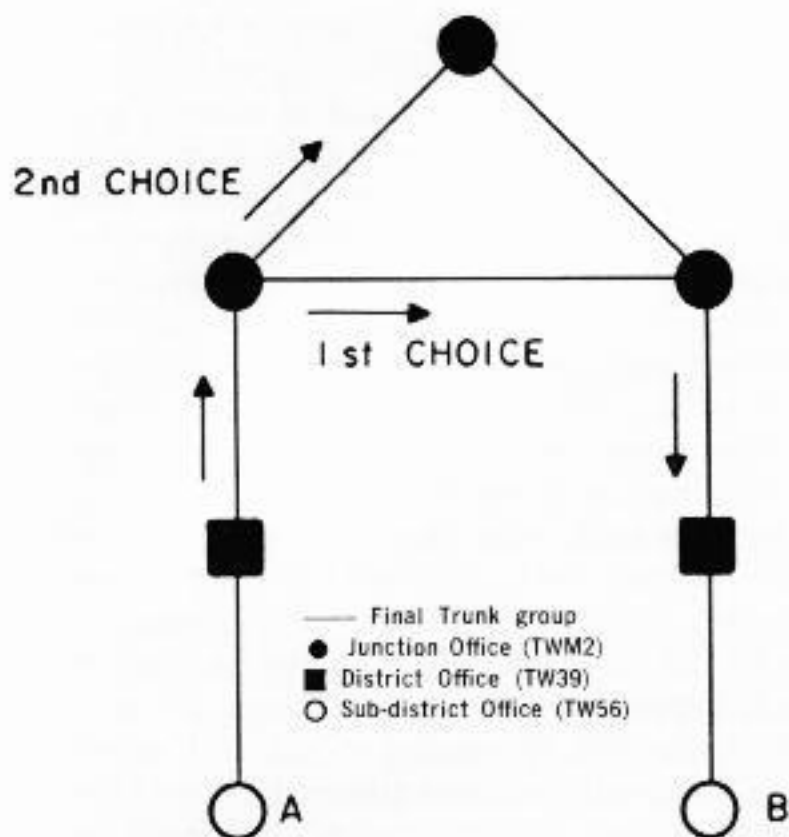


Figure 1. Phase I Simplified System

centrate subscribers into a parent district or junction office. A simplified first phase systems approach is indicated in Figure 1. Also shown in this figure is the alternate choice routing on a call originating in sub-district A, for a subscriber terminated in sub-district B.

Phase II

As the request for Telex service approached 10,000 subscribers, it became apparent that the equipment deemed applicable to the first phase would have to be supplemented or modified to fit into the expanded needs or the second phase of the Telex network. The features required for new exchange equipment proposed for phase 2, for a system of 100,000 subscribers, are as follows:

1. Full availability on trunk groups in order to increase the trunk utilization efficiency.²
2. Complete flexibility in alternate routing in order to gain the maximum advantage of high usage and final trunk groups in planning an economical system.
3. Two-out-of-five coded transmission of control signals between exchanges in order to decrease the connection set up time; therefore decreasing the holding time

on common control equipment and decreasing the quantity of units required.

4. Subscriber classification by providing a two digit combination, for each subscriber, which precedes the control signals. This classification is compared with the destination subscribers classification in order to allow the connection or not.

5. Flexible subscriber concentrations in order to accommodate various traffic loads and an expandable tandem directional matrix that can handle heavy trunk loads.

6. The capability to terminate up to 30 sub-districts in a district.

7. Installation to a great extent on a plug-in basis in order to decrease installation time, effort and expense. Simplified grading and mixing patterns are also required.

8. In maintenance, much consideration was given to such things as: line and trunk routiners, trouble display and print out equipment, automatic fault diagnostic routine with lock-out, and plug-in functional units plus redundancy in all common control units.

These features are now being provided in our CSR4 and TWK4 equipment, described in this issue of the TECHNICAL REVIEW and in a new line of equipment called TWKD. Different type exchanges have been considered because of the economical advantages gained through engineering specific exchanges for particular system's levels and capacities. The CSR4 exchange can be used to terminate 8,000 subscribers or equivalent trunk groups; therefore designating its use as a junction or large district. The TWKD is a tandem exchange that can work in conjunction with sub-districts terminating approximately 2500 subscribers; therefore fixing its place at the medium size district level. The TWK4 is a modular type exchange that grows in increments of 50 to a maximum capacity of 200 subscribers; therefore making it a sub-district. Figure 2 indicates the simplified system for the second phase. A typical alternate route choice is illustrated in Figure 2 for comparison with Figure 1.

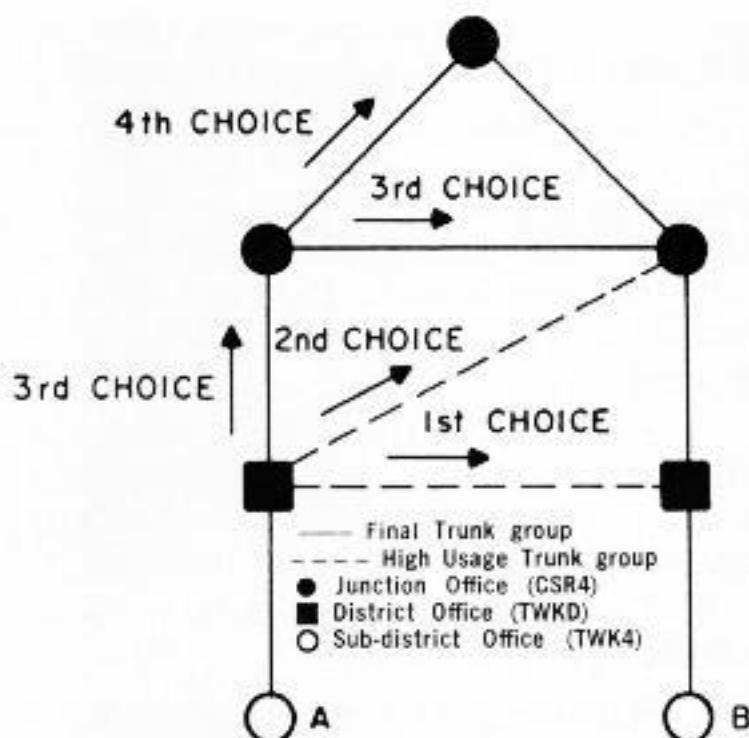


Figure 2. Phase II Simplified System

Numbering Plan

The numbering plan adopted for phase 1 Telex was based upon the type of equipment then used. This plan, illustrated in Figure 3 was essentially a step-by-step plan where each digit performed an actual routing process and was usually absorbed after being used. The first digit 0 was used by the TW39 district exchange as a local call discriminator. If the first digit is zero then the call was routed to the district exchange's parent junction and the zero (0) is absorbed. The junction then looks at the second digit to decide if the call should remain in its junction area. If the call is to be handled by this junction then the second digit is absorbed and the third digit is examined to select a district and then absorbed. The fourth digit is then used to select a sub-district, and the remaining digits are transmitted to the sub-district to select the actual subscriber. If the call is a local call, the subscriber can determine this from the first three digits in the directory. If they are the same as the calling party, then only the digits to the right of the hyphen are dialed. The absence of the first digit zero indicates that the call is to be locally routed. Under this numbering system a district can only terminate theoretically 9 sub-districts.

The numbering plan adopted for phase 2 Telex is based upon register-control type equipment being used at district and junction levels. However, this numbering plan illustrated in Figure 4, is different. Here, the first two digits represents a region which automatically determines whether the call is local or should be routed to another exchange. If it is to be routed to another exchange, the choice between prime or alternate routes is also decided before these digits are forwarded to the next exchange. The home exchange of the regional designator will use the first two digits, or the designator, in combination with the third digit to pick the applicable sub-district or thousand group of subscribers. The remaining digits will select the hundreds group of subscribers and the actual subscribers' terminal. It should be noted that more than one regional designator can be used for the same home exchange; therefore making the number of sub-districts expandable beyond the previously mentioned eight.

This new numbering plan has the following advantages.

1. Eliminates the dialing of the digit zero (0) on transient calls which are approximately 90 percent of all calls.
2. The full combination of digits is dialed on all calls.
3. Since the regional designator is read and retransmitted on transient calls, more effective use is made of high usage and final trunk groups.
4. Allows greater flexibility in assignment of sub districts, because more than one regional designator may be assigned to the same region.

New Horizons

Planning the Western Union Telex network is not static, rather it is constantly changing. Because private business and government are our customers, the Western Union Telex network must keep up-to-date with modern business requirements. New services are constantly being planned. These new services using new codes and new baud rates will further enhance the overall system.

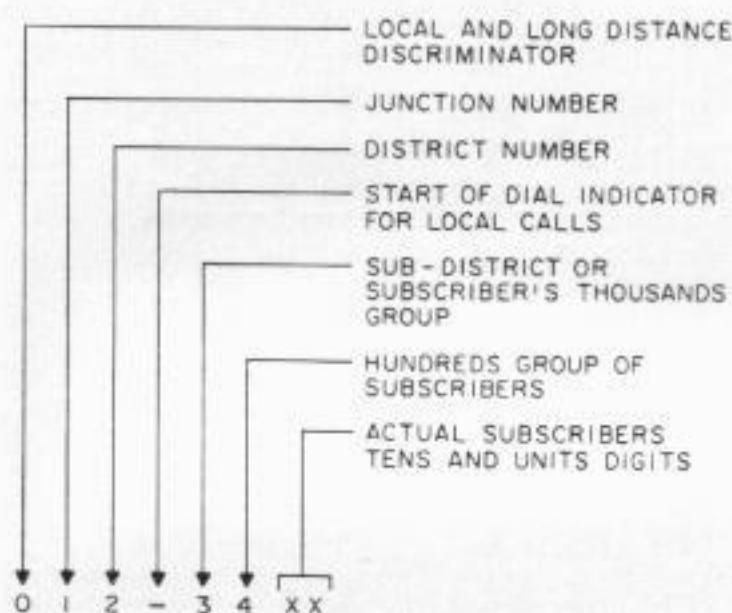
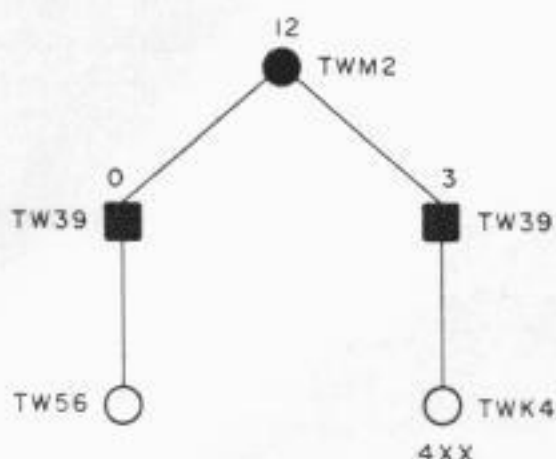


Figure 3. Phase I Numbering System

As the system grows and technologies advance, it is expected that new exchange types with more demonstrable economies may be incorporated in the overall plan. Registers, markers and translators with computer techniques, more sophisticated methods of billing, pulse code modulation, solid state matrices, and automatic load leveling are but a few of the areas under investigation for the future.

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1. Telex in New York, Philip R. Easterlin, Western Union Technical Review, Vol. 13, No. 2, April 1959.
2. Traffic Evaluation, K. M. Jockers, Western Union Technical Review, Vol. 17, No. 4, October 1963.

Kenneth M. Jockers, Telex Systems planning engineer in the Information Systems and Services Department, has been responsible for the basic planning of the Telex system and for the development and implementation of the new equipment, such as the CSR4, TWK4, TWM2 and Type 600 exchanges.

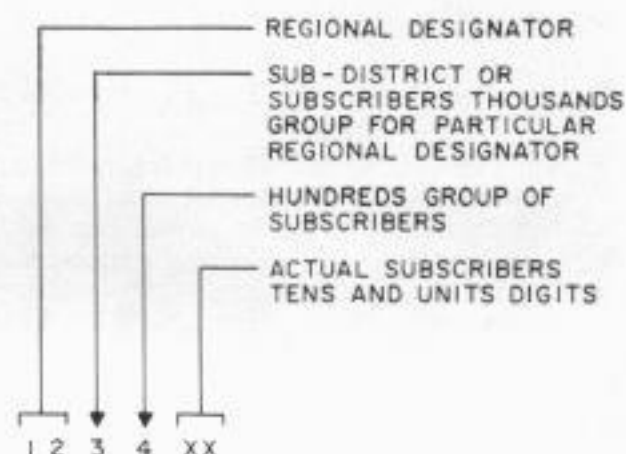
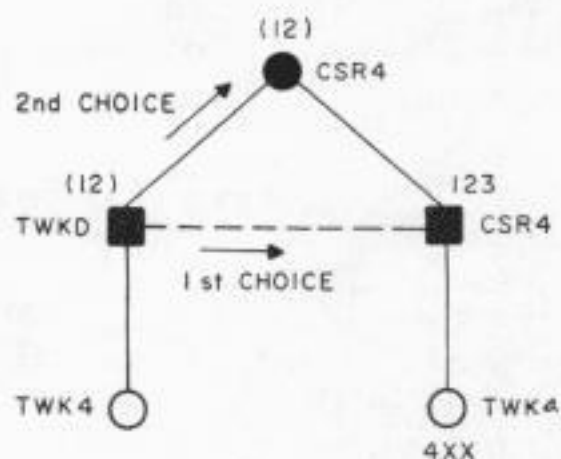
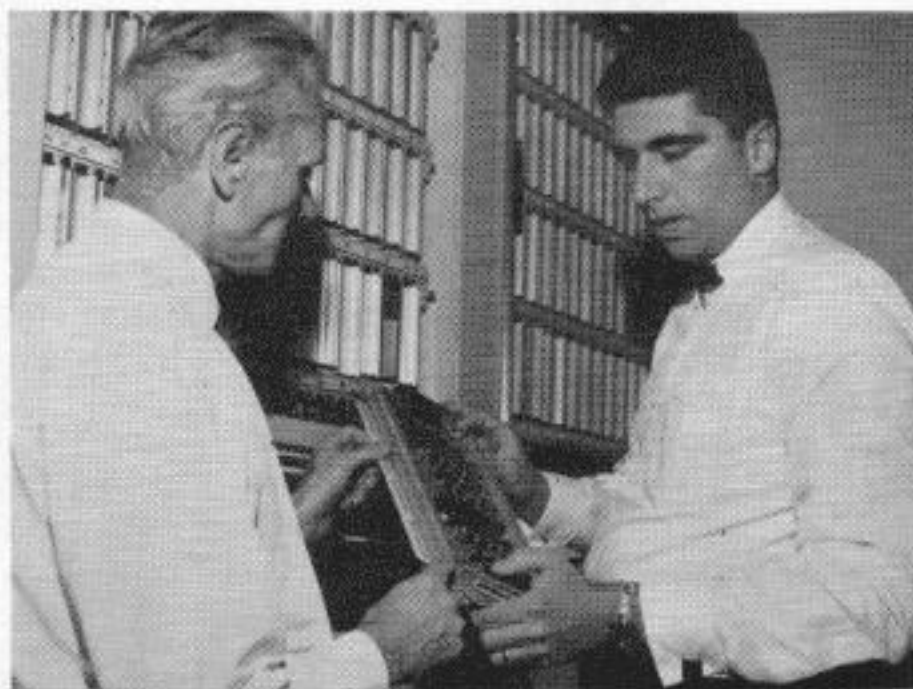


Figure 4. Phase II Numbering System



Kenneth Jockers is shown above (on the right) discussing one of the modules for the new TWKD exchange with Hans Dobermann of Siemens while on a recent visit to Siemens, in Munich, West Germany.

telex

switching system

TWK4

—John J. Wunner Jr.

The Automatic Teleprinter Exchange, TWK4, is a sub-district level exchange connected to a parent exchange (district office or junction office) by means of trunks. The basic TWK4 has facilities to terminate up to 50 subscribers with up to 12 two-way Trunk Repeaters and 3 Local Repeaters (for connections within the TWK4 service area). By adding more units, the TWK4 can be expanded to terminate a maximum of 200 subscribers with up to 48 Trunk Repeaters and 12 Local Repeaters.

Equipment

The TWK4 equipment is contained in steel cabinets which stand seven feet high. Two cabinets are required for an exchange of up to 50 subscribers: a Common Control cabinet and a subscriber cabinet. The Common Control cabinet contains the facilities for zoning, dial digit evaluation and class-of-service evaluation. The subscriber cabinet contains the subscriber facilities, Repeaters and Storages. One cabinet is required for each additional 50 subscribers. A configuration of five cabinets for a maximum of 200 subscribers is shown in Figure 1.

The Supervisory Panel, located in the upper part of each subscriber cabinet, contains the automatic circuit breakers, heavy-duty subscriber line and bias resistors, blocking buttons, busy lamps (for the Repeaters and Storages) and two milliammeters (for monitoring the subscriber and trunk lines.) Installed below the Supervisory panel are the subscriber pulse rate counters.

The lower part of the subscriber cabinet contains seven shelf frames, one of which is shown in Figure 2, which accommodate the individual equipment units (modules) of the system, and which interconnect electrically the modules of one shelf. The shelf frames also terminate the connections

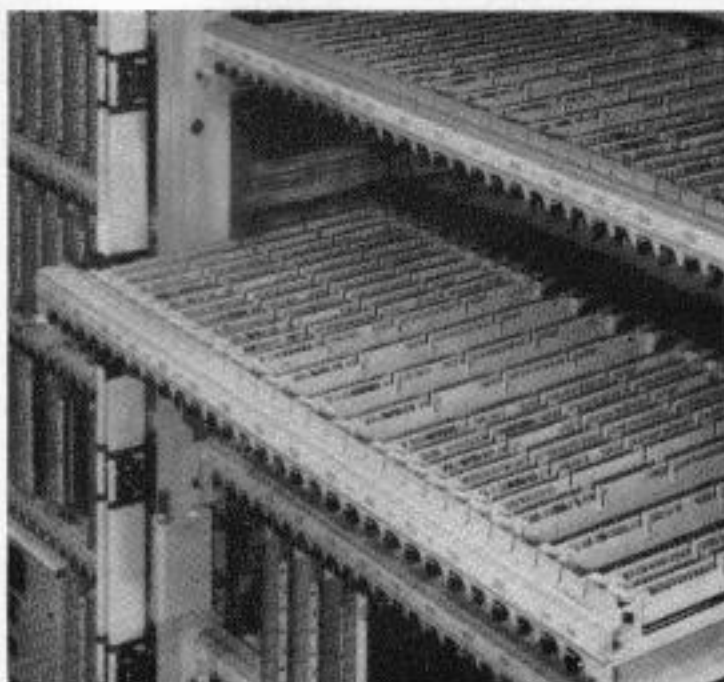


Figure 2. Shelf Frame

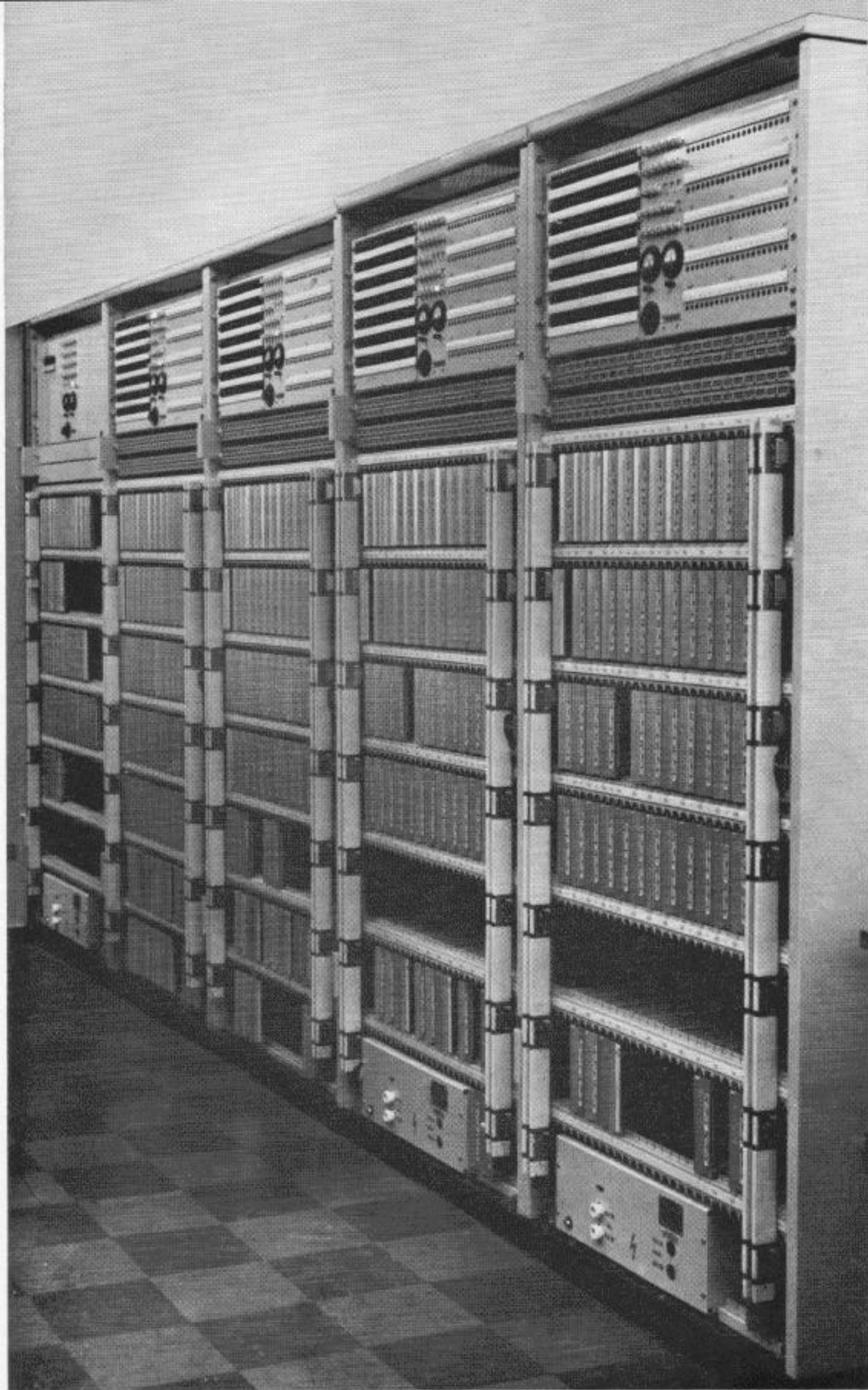


Figure 1. A 200-Subscriber TWK4 Exchange manufactured by Siemens

from the Supervisory Panel as well as the connections from adjacent cabinets. Shelf connectors, shown in Figure 3, are used to interconnect electrically each of the shelf frames.

The electrical components, such as relays, resistors, diodes, etc. are mounted in modules, each of which consists of a metal frame provided with a 104-point terminal strip connector. This connector mates with a keylock receptacle installed on the shelf frame as shown in Figure 4. After the

module has been inserted into the keylock receptacle, it is locked in by means of a special key. As the key is turned, the 104 double contacts of the receptacle mate with the contacts of the module terminal strip, thus providing an electrical connection between the shelf frame and the particular module, as shown in Figure 5. A mechanical interlock allows the module to be locked in only when the 104 terminals of the module are aligned with the 104 terminals of the connector. This also

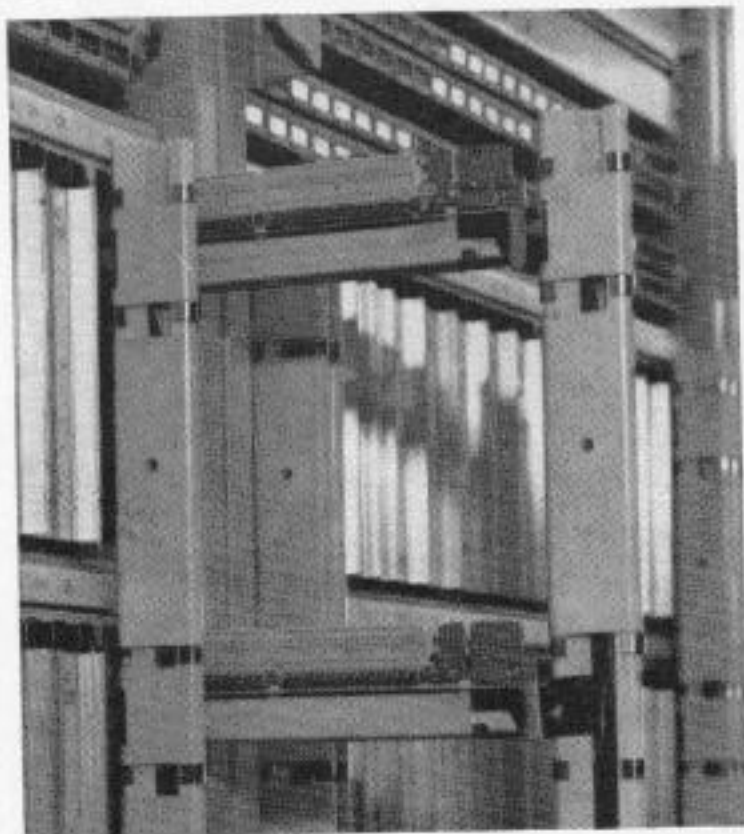


Fig. 3. Shelf Connector

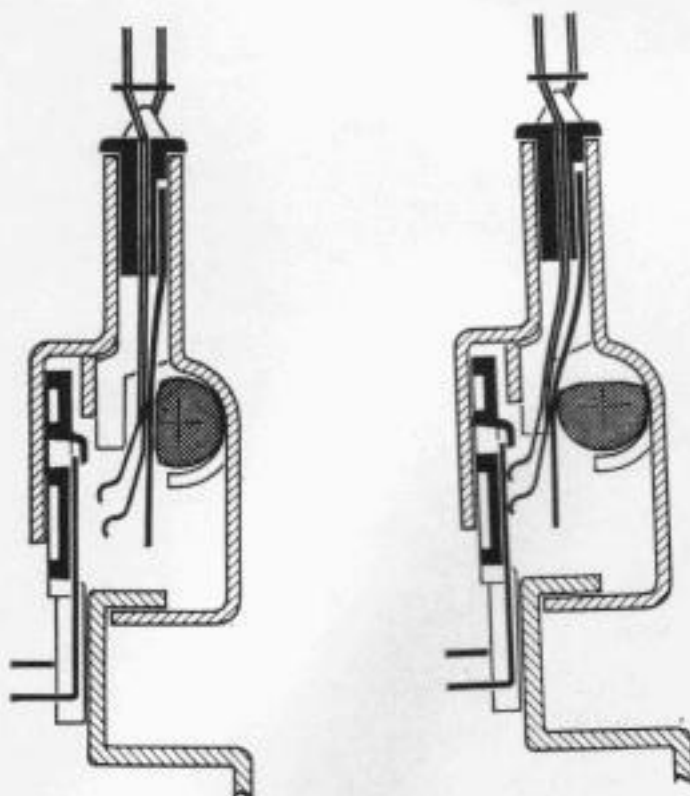


Fig. 5. Mechanical Interlock of Shelf Frame and Module

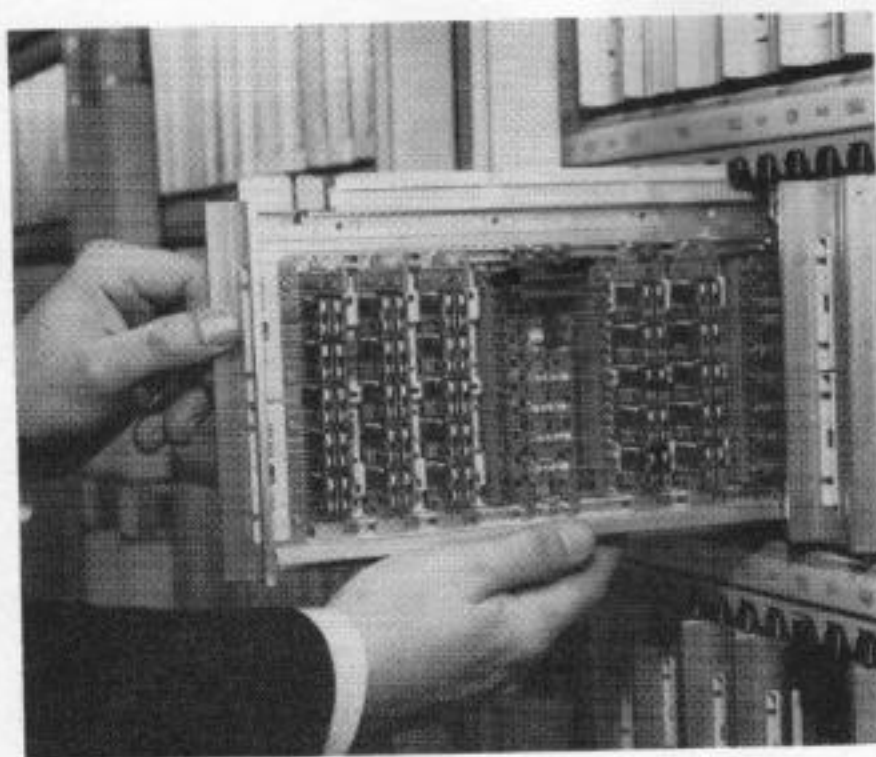


Figure 4. Module withdrawn from Shelf

ensures that a module can be removed only when the electrical connections have been broken by unlocking the key.

The subscriber and trunk lines are connected to the Supervisory Panel from a terminal box via two cables, each of which is fitted with a 104-point terminal strip connector.

The TWK4 lends itself to mass production due to the fact that each module is machine-wired under the control of a programmed tape and computer. The components, such as module frames, shelves and 104-point terminal strip connectors are of standard construction, differing only in wiring, thus reducing manufacturing costs.

Another contributing factor to the low cost of the TWK4 is the use of the ESK relay. A 5-unit relay strip is shown in Figure 6. Almost all functional relays in the TWK4 are of the ESK type. Only the telegraph relays in the Repeaters are different; these are polar relays of the conventional design. The ESK relays used are basically of the same simple construction, differing from each other only in coil resistance and contact arrangement. The simplicity of the relay design is due primarily to the fact that the two moving parts of a relay, the armature and the contact springs, are here combined into a single unit as shown

in Figure 7. This arrangement is also responsible for the extremely high switching speed (normally less than 2 milliseconds).

When the ESK relay is energized, the contact armatures move towards the polar strips; however, the contacts mate before the armatures touch the polar strips. Since each contact is actually an armature, the force with which each contact armature is accelerated is independent of the number of contacts. The fact that these relays are assembled in groups of five, permits economical production, and at the same time, presents a unit which is sufficiently flexible to fulfill most switching circuit requirements.

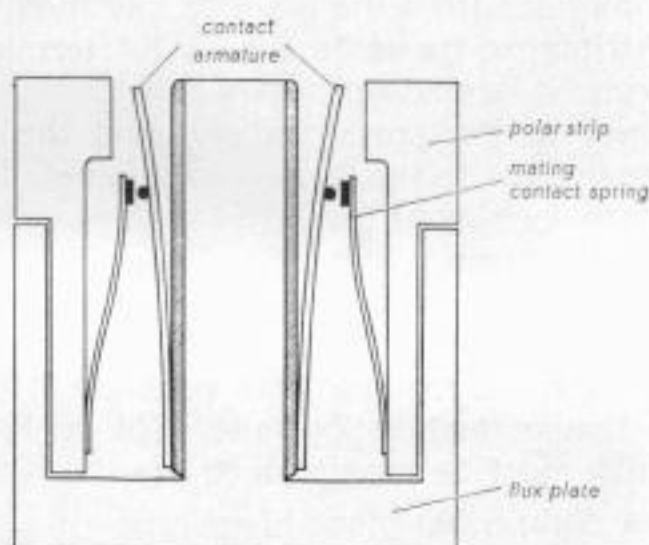


Figure 7. Simplified Relay Design

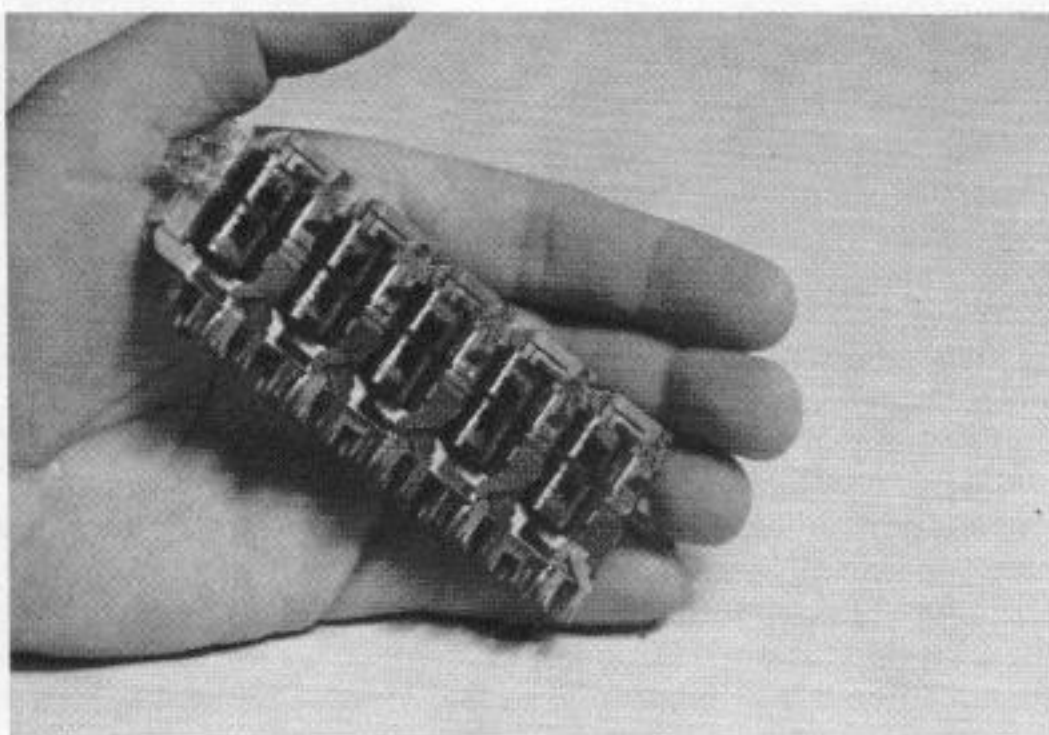


Figure 6. Relay Strip

Ease of Installation

A typical TWK4 exchange can be completely installed and made ready for testing within a period of three to five days. Approximately two weeks are allowed for a thorough testing of the TWK4 functions and for additional training of the field personnel who will be responsible for the maintenance of the TWK4.

Although the compact construction and computer-controlled wiring of the modules tend to make the TWK4 Exchange more intricate than other Telex exchanges, the installation is quite easy. The only major wiring required at the site is the wiring necessary to connect the subscriber and trunk lines from the main or intermediate distributing frame to the TWK4 terminal boxes. It is also necessary to wire the ac power to the power supply, and the dc line voltage to the Supervisory Panel. The internal wiring of the TWK4 is done by the manufacturer.

The major part of the installation consists of programming the individual modules for the requirements peculiar to the particular installation site. The criteria which must be programmed are:

- Subscriber mode of operation
- Evaluation of two or three digits on an incoming call
- Evaluation of three or four digits on an outgoing call
- Evaluation of collective numbers
- Assignment of pulse rates
- Evaluation of local traffic digits.

Most of the programming is performed by inserting switching diodes on printed circuit diode matrix cards. Should there be a change which would require an adjustment in the programming, this method facilitates the change. This type of change occurs for instance, when Telex service is extended to a new location, and an adjustment in the assignment of pulse rates is necessary.

The construction of the TWK4 is such that when, for example, a location which has a 50-subscriber, 2-cabinet configuration is expanded by adding an additional subscriber cabinet, there is a minimum interference with the existing equipment during expansion.

Special Features

• Common Control

The primary feature of the TWK4 Exchange is the use of a central control device called the Common Control, which coordinates all the functions of the exchange, as illustrated in Figure 8. Each control process is governed by one of the following programs in the Common Control which is selected by a request from one of the units of the TWK4:

Outgoing Seizure

This program connects a calling subscriber to a Trunk Repeater and arranges the connection of a Storage to the chosen Trunk Repeater.

Incoming Seizure

This program arranges the connection of a Storage to the particular Trunk Repeater which has been seized by the parent exchange.

End-of-Selection/Through Connection

This program arranges the actual connection of a call and causes the release of the units used in setting up the connection.

End-of-Selection/Zone Information

This program arranges for the transmission, and monitors the interpretation of the zoning information required to select the correct pulse rate.

End-of-Selection/Local Traffic

This program arranges to have a call transferred from a Trunk Repeater to a Local Repeater during the inter-digit time.

End-of-Selection/Collective Number

This program transfers the functions of marking the subscriber to be connected from the Dial Evaluator to the Collective Number Evaluator.

If several requests are to be met by the Common Control, they are handled successively in the order of their importance.

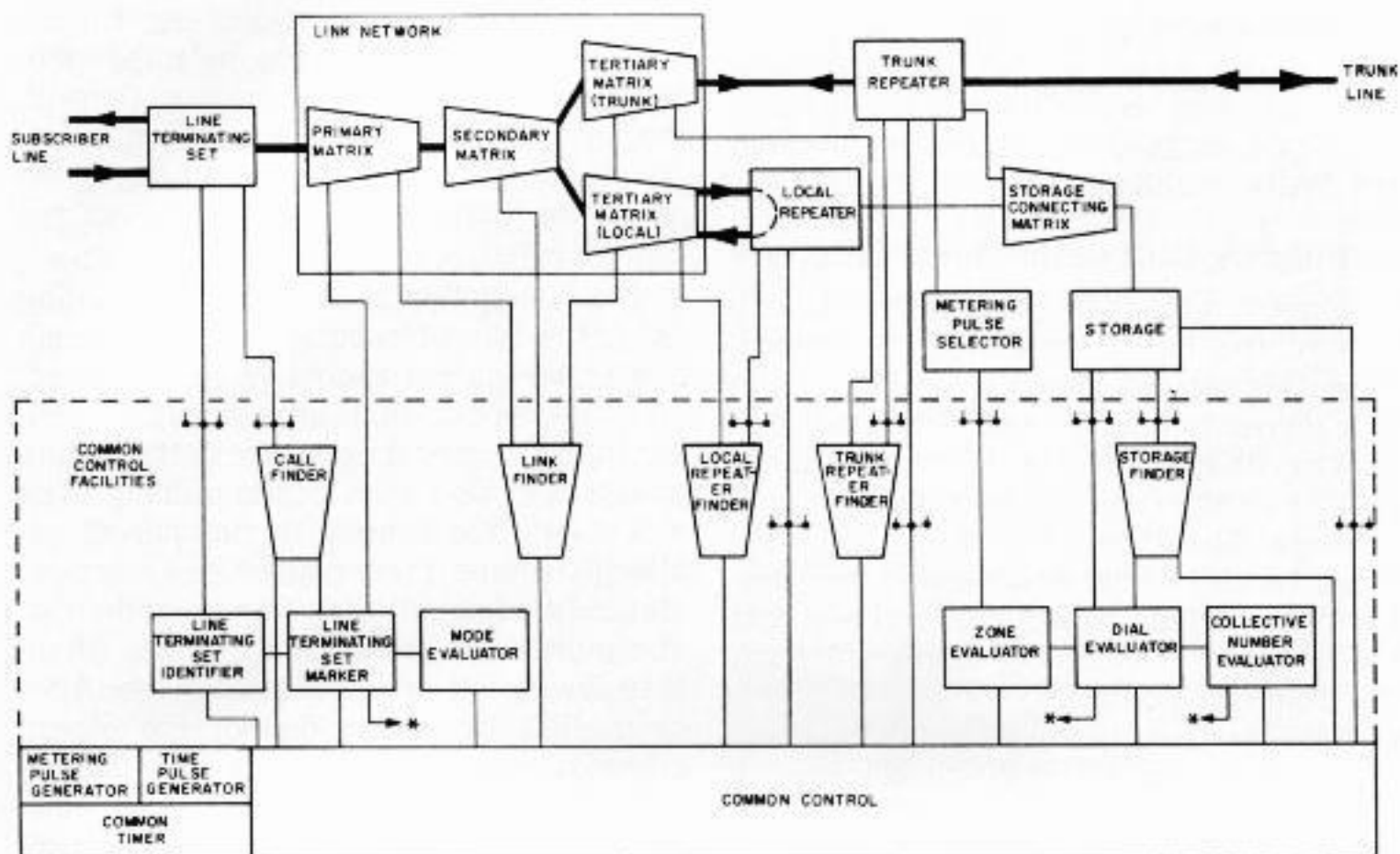


Figure 8. Block Diagram of the TWK4 Exchange

When a call is accepted by the TWK4 Exchange, it may request as many as four different programs from the Common Control during the setting up of a connection. The Common Control is designed to process programs quickly since it must be available to run other programs for calls being processed at the same time. Auxiliary units such as finders, markers, identifiers and evaluators as illustrated in Figure 8, are available to the Common Control, for use in running the various programs.

• Local Traffic

To reduce the holding time on trunks, a message between two subscribers connected to the same TWK4 can be handled exclusively by the facilities of the TWK4 exchange. In this case, the functions of transmitting the telegraph signals of the calling subscriber to the called subscriber and vice versa and of supervising the connection, are performed by the Local Repeater, thus avoiding the use of two Trunk

Repeaters for this type of call.

• Class of Service Information

The TWK4 exchange is capable of sending and receiving class-of-service information and receiving dial information in a two-out-of-five code. The coded class of service information can be used to insure compatibility of the calling and the called subscribers. When a subscriber of the TWK4 exchange is connected to a Trunk Repeater, his class-of-service code is automatically transmitted to the parent exchange. Comparison of the class-of-service codes is made at the exchange of the called subscriber. When the TWK4 receives an incoming call, it makes a comparison of the class-of-service codes of the called and calling subscriber, before making the connection. It should be noted that this feature is optional. While every TWK4 exchange has the capability of class-of-service operation, it may be omitted by programming the associated modules accordingly.

Types of Calls

Using Figure 8 as a reference, we can trace three types of calls: an outgoing trunk call, an incoming trunk call, and local call, as they are processed through the TWK4 exchange.

a) Outgoing Call (via the Parent Exchange)

When a subscriber depresses his call button, the Line Terminating Set recognizes this request either by an increase in loop current (in the case of a local subscriber) or by a reversal in the polarity of the line (in the case of a long-distance subscriber). The Line Terminating Set activates the Call Finder which stores the number of the calling subscriber, and requests the program, "Outgoing Seizure," from the Common Control.

The Common Control instructs the Common Timer (the unit which coordinates all the timing functions in the TWK4) to start the Pulse Generator motors, and then via the Call Finder, instructs the Line Terminating Set Marker to mark the subscriber-side output of the Link Network. This Link Network, which provides the connecting paths from the Line Terminating Sets to the Trunk Repeaters, is a three stage, four-wire matrix utilizing ESK relays for each crosspoint. Then, the Line Terminating Set Marker, via the Mode Evaluator, informs the Common Control of the mode-of-operation (local or long-distance) of the calling subscriber. The Common Control stores this information for later reference.

The Common Control then chooses, via the Trunk Repeater Finder, a free Trunk Repeater. The Trunk Repeater Finder marks the repeater-side output of the Link Network. Next, the Common Control chooses, via the Storage Finder, a free Storage which is then connected to the Trunk Repeater via the Storage Connecting Matrix. The Storage performs the function of reading and storing each dial digit as it is passed from the calling subscriber to the Trunk Repeater.

Information regarding the subscriber mode-of-operation is transferred to the Trunk Repeater, which adjusts its circuits accordingly. The Common Control instructs the Link Finder to select a free connecting

path in the Link Network between the calling Line Terminating Set and the chosen Trunk Repeater. After the selected path has been tested by the Common Control, the Line Terminating Set and Trunk Repeater are connected to each other. At this point, the Common Control Facilities are disconnected.

The connection of the Line Terminating Set to the Trunk Repeater causes the trunk line to the parent exchange to be seized. The "Proceed-to-Dial" signal is transmitted from the parent exchange to the calling subscriber, who then starts dialing. The dial digits are passed to the parent exchange where they cause the selection stages to be set. At the same time, the dial digits are received by the Storage where they are stored in a 2-out-of-5 code. After each digit has been dialed, the stored information is passed to the Dial Evaluator, which translates the 2-out-of-5 code into the 1-out-of-10 code required for evaluation. The Dial Evaluator passes the dial information to the Zone Evaluator which determines the rate zone of the desired connection (the metering pulse rate) when it has received enough dial digits. The Common Control is again seized at this point and runs the program "End-of-Selection/Zone Information" to provide for the transmission and interpretation of the rate zone information. When the rate zone information has been transferred to the Metering Pulse Selector, the Common Control again releases. The Metering Pulse Selector will, upon receiving the call-connected signal from the Trunk Repeater, connect the applicable pulse rate to the calling subscriber's pulse rate counter. When an invalid combination of digits is dialed, the call is immediately disconnected.

Upon reception of the call-connected signal from the parent exchange, the Metering Pulse Selector begins transmitting the metering pulses to the subscriber's pulse rate counter via the Link Network, and message transmission commences. The Trunk Repeater supervises the condition of the connection and upon detection of the disconnect signal, releases the connection without resorting to the Common Control.

b) Incoming Call (via the Parent Exchange)

If a call from the parent exchange arrives on a trunk line, the request for the "Incoming Seizure" program is sent to the Common Control from the Trunk Repeater. The Common Control determines the Trunk Repeater making the request via the Trunk Repeater Finder and locates a free Storage via the Storage Finder. The Storage is then connected to the Trunk Repeater via the Storage Connecting Matrix. Since this connection must be made within the inter-digit time of 600 msec., this program has priority over all other programs in the Common Control. Upon the connection of the Storage, the Common Control is disconnected.

The Storage accepts the incoming digits and passes them to the Dial Evaluator for interpretation. The Dial Evaluator decodes the digits and, when enough digits have been received, requests the "End-of-Selection/Through Connection" program from the Common Control which then instructs the Dial Evaluator to pass the number of the called subscriber to the Line Terminating Set Marker. If the Dial Evaluator recognizes, from the digits dialed, that the call is to be connected to a collective number subscriber, it requests the "End-of-Selection/Collective Number" program from the Common Control. In this case, the Line Terminating Set Marker receives the information on the position to be connected from the Collective Number Evaluator. The two ends of the Link Network are marked via the Line Terminating Set Marker and the Trunk Repeater Finder. The Link Finder determines a free link which is then tested by the Common Control. Before the actual through-connection is made, the Common Control carries out a "busy-condition" check of the called subscriber, determines the operating mode of the called Line Terminating Set and passes this information on to the Trunk Repeater. The call is then through-connected.

The Common Control, Dial Evaluator and Storage are then released. Supervision of the line and interpretation of the clearing signal are handled by the Repeater in the same way as described for an outgoing call.

c) Local Call

Initially, the processes are the same as described for an outgoing call via the parent exchange. If the Dial Evaluator finds, from the digits dialed, that the call may be connected internally via a Local Repeater, it requests the "End-of-Selection/Local Traffic" program from the Common Control. Via the Storage Finder, the Common Control determines the particular Storage associated with this call and then, the particular Trunk Repeater. Potential is applied via the Trunk Repeater Finder, the Trunk Repeater and the Link Network to one of the wires routed to the Line Terminating Set. The Line Terminating Set Identifier connected to this wire now determines the Line Terminating Set to be re-connected to a Local Repeater. It passes on this information to the Line Terminating Set Marker, thus marking the particular Line Terminating Set on the subscriber-side output of the Link Network. Via the Local Repeater Finder, the Common Control locates a free Local Repeater. The Local Repeater Finder marks the repeater-side output of the Link Network. The connection between the Line Terminating Set and the Trunk Repeater is released, whereby the trunk line is also released and the seized selection stages in the parent exchange are cleared. The Storage is disconnected from the Trunk Repeater, causing it to clear any digits stored up to this point, and is re-connected to the Local Repeater. The Common Control tests the link chosen by the Link Finder. The link between the Line Terminating Set and the Local Repeater is then through-connected. The Common Control Facilities are released. All the above processes take place in the inter-digit time.

From this point on, the call is processed in the same manner as the "Incoming Call" described previously except that the call is now on a Local Repeater. In addition the Dial Evaluator determines from the digits dialed if the call is to be connected free-of-charge or at the fixed local rate. For a chargeable call, the metering pulses are fed directly into the Local Repeater and then, via the Link Network, to the calling subscriber's rate counter.

Summary

The TWK4 satisfies Western Union's requirement for a sub-district exchange which can most economically provide Telex service to those small cities in the United States which are located in areas of potential growth. The TWK4 will be installed to replace the TW56, which has a smaller capacity (20 subscribers). It will also be installed in completely new locations. As the number of Telex subscribers grows in a TWK4 service area, the TWK4 facilities may be expanded, in steps, to meet any need to a maximum of 200 subscribers. It is planned, that within a couple years approximately 200 TWK4 exchanges will be in operation at the sub-district level, terminating about half of the total number of subscribers in the Telex system at that time.

At the present time, preliminary designs are being considered for a new exchange, the TWKD, which has many of the design features of the TWK4. The TWKD exchange will serve the Telex system at the district level.

The TWKD is a tandem switching exchange using mostly ESK relays in the circuit design. The construction will be similar to the TWK4, in that the electrical

components will be mounted on slide-in modules which are inserted into shelves for electrical connection to other units. The design will differ in that enclosed racks will be used rather than stand-up cabinets. The use of an enclosed rack will allow more height for mounting the equipment than would be available in a TWK4 type cabinet.

The TWKD will have a maximum capacity of 792 Trunk Repeaters and will route in up to 20 directions, using a four-stage folded matrix, with up to five alternate route possibilities for certain trunk groups. The designations of the individual Trunk Repeaters to the various directions can be freely chosen by means of programming diodes on printed circuit diode matrix cards.

The TWKD Register will have the capability of receiving 2-out-of-5 dial information or dial pulses; it also may or may not send and receive class-of-service (COS) information. If the TWKD is programmed to receive COS, it can use this information to determine a particular route.

The TWKD will be used to terminate all types of the presently used sub-districts, namely TWK4, TW56, and TW39; and in most cases each TWKD will have a TWK4 co-located with it to serve local subscribers.

JOHN J. WUNNER, JR. has been a member of the Telex Section, Information Systems and Services Department, since joining Western Union in June 1965. His work has primarily been concerned with the testing and evaluation of the TWK exchanges and preparation of the operations specifications of the TWK type exchanges.

Mr. Wunner received his Bachelor of Electrical Engineering degree from Manhattan College.



our special telex issue

Our Response to Challenge

We, in Western Union, today take as a challenge what seemed, only a few years ago, a fantastic speculation. The challenge is the need to put in place a nationwide data communication network that will give anyone in business or government instant access to computer-stored information. Some of what has been done to date to meet this challenge has been documented, in this special issue on Telex, by some of our most knowledgeable engineers.

Western Union Telex has grown phenomenally during the eight years since its introduction. As this issue goes to press, there are more than 16,000 subscribers, with 1,350 additional waiting for service; and Telex revenues have reached a \$25 million annual rate.

We are now preparing to become a nationwide information utility, providing a broad range of communication/information systems and services to customers of all kinds; and there appears to be almost no limit to the potential for future growth of Telex service. All who have contributed to its growth up to the present must now face the new challenges of the "information revolution."

This special issue on Expanded Telex Services is the largest issue in the history of Technical Review. It is a tribute to our authors who are experts in the Telex field — and a tribute to all others who are helping to create a new future for Western Union Telex.

Mary C. Killilea

pulse rate monitor

—Melvyn M. Feldman

The Pulse Rate Monitor is a device used to sample pulses to the pulse generator. When a generator is seized, and when the AUTO-STOP STEP switch is in the AUTO position the monitor samples all pulse rates. When the generator is released, the last pulse rate sampled is indicated on a pulse lamp on the monitor panel.

In Telex exchanges timing of pulses is a vital factor. Western Union recently developed a new Pulse Generator Rate Monitor 11346, which insures correct pulse generator outputs and samples electronically all pulses sent via the pulse generator.

It is important to note that in each Telex exchange, there are two pulse generators. One generator is normally on-line; the other is used as fall back. If the fall back is used, an office alarm condition occurs.

The monitor is designed so that an alarm is registered if, (1) pulse rates vary by more than a predetermined frequency, (2) a no-pulse condition occurs (open or grounded lead), or (3) a continuous pulse condition exists.

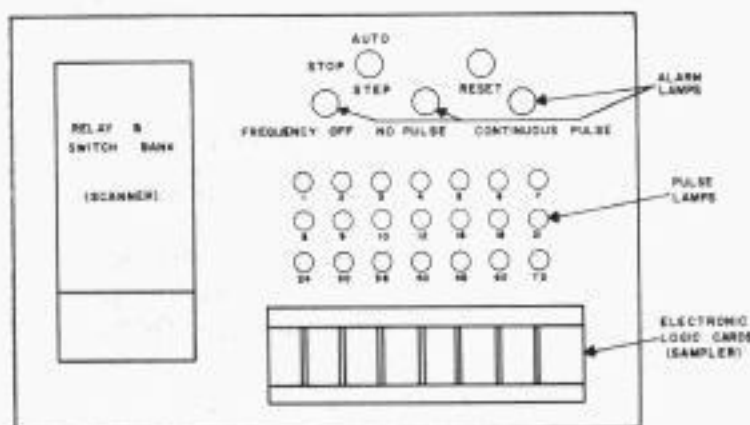


Figure 1. Front Panel of Pulse Rate Monitor.

Figure 1 shows the arrangement of the indicators on the Pulse Generator Monitor Panel. The panel shows four basic sections: 1) an electromechanical scanner, to

the left, 2) a control section consisting of an AUTO-STOP-STEP switch and RESET button, 3) an alarm section consisting of: 3 lamps labelled FREQUENCY-OFF, NO-PULSE, and CONTINUOUS-PULSE plus 21 pulse lamps labelled with specific pulse rates, and 4) a sampler section consisting of electronic logic cards. The numbers associated with the pulse lamps indicate the pulse rate sampled in pulses per minute.

Automatic Sampling

The Rate Monitor automatically samples all pulse rates to the Pulse Generator, as viewed in the scanner. If a fault condition occurs, while the Pulse Generator is seized, the alarm relay on the monitor is operated. This causes an audible and visual alarm, the scanner stops scanning and one of the 3 alarm lamps lights up. One of the 21 pulse indicating lamps lights up too, indicating the pulse rate which faulted. Thus, the maintainer can pinpoint the pulse rate in trouble and take corrective action. The AUTO-STOP-STEP switch is then thrown to the STOP position.

When the fault is cleared, the RESET button is depressed. This clears the exchange alarm and again allows the monitor to sample the pulse rate.

If the fault has not been cleared when the RESET button is depressed, the alarm will be reinitiated. If no alarm condition occurs, when this button is depressed, the AUTO-STOP-STEP switch is thrown to AUTO position, thus restarting the scanner.

Manual Sampling

In addition to automatic sampling, a specific pulse rate can be sampled manually by alternately moving the AUTO-STOP-STEP switch from the STOP to the STEP position. Each time this is performed, the switch steps once.

Alarms

The three alarm lights indicate the following three alarm conditions:

a) FREQUENCY-OFF is an alarm condition which is indicated when a pulse frequency varies by more than a predetermined amount. If the frequency is greater than that limit, the following steps take place: 1) the FREQUENCY OFF lamp lights, 2) the monitor stops scanning, 3) the office alarm is actuated and 4) the lamp associated with the sampled pulse lights up.

b) NO PULSE is a condition which occurs when an open circuit or ground is on a pulse output lead.

If the no pulse condition persists for 40 seconds, the NO PULSE lamp comes on and consequently the office alarm is actuated. The lamp associated with the sampled pulse will also be on.

c) A CONTINUOUS PULSE alarm indicates that the -60 volts lead is shorted to a pulse output lead. If, within 40 seconds, the condition is not cleared, the CONTINUOUS PULSE lamp will light and the office alarm is actuated. As in the alarms of NO-PULSE and FREQUENCY-OFF, the lamp associated with the sampled pulse will also be on.

Controls

The controls at the top of the panel constitute a lever switch and a reset button.

b) When a definite pulse rate is sampled, the AUTO-STOP-STEP switch is used to step the scanner to this desired pulse rate. This is done by throwing the switch alternately between the STEP and STOP positions. When the desired pulse rate is reached, the AUTO-STOP-STEP is left in the STOP position. Then the pulse rate will be continuously sampled.

b) Each time an alarm condition occurs, and after the alarm condition is cleared, the RESET button is depressed; thus, removing the ground from the monitor alarm relays and resetting the logic. This turns off the alarm lamp.

The Pulse Generator Rate Monitor gives instant indication of on-line trouble in TELEX exchanges. Mitigation of these troubles is more quickly rendered; thus, more efficient Telex service for our subscribers is provided.

MELVYN M. FELDMAN, Project Engineer in the Information Systems and Services Department is responsible for all Electronic and Mechanical Packaging related to the Telex program.

He joined Western Union in 1956 as a draftsman, and was later promoted to Engineering Assistant. In this capacity he assisted in the design of Plan 55, 57 and 59 Projects.

Prior to joining the company in 1956, Mr. Feldman enlisted in the United States Navy and served as a navigator aboard an ammunition ship in Korea for four years.

Mr. Feldman received his Associate Arts and Science Degree in Structural Technology in 1960 and is working towards his Bachelor of Science Degree in Physics at Brooklyn College in New York City.



outstation options

—Peter J. Lavitola

To meet the increasing needs of Telex subscribers, Western Union is now offering a variety of options related to operating outstation equipment. These new options provide more efficient service in meeting the data communication needs of our customers.

Three different types of options are presently offered in Telex.

- Control of Auxiliary Devices
- Tape Transmitter Control
- Automatic Dialer

Control of Auxiliary Devices

Auxiliary devices may be a computer or other business machine, or a second printer.

1) Computer or business machine

A Telex subscriber can send and receive messages directly from a computer or other business machine used as an auxiliary device. It is usually connected to the Telex line via a Line Adapter, as shown in Figure 1. This adapter serves as a buffer to isolate Telex from the many different signalling levels of the subscriber's equipment, such as a computer or other business machine.

When Line Adapter 11671-A is used, the auxiliary device is operated in an Inquiry mode and cannot initiate calls to the Telex exchange. However a call can be initiated from the Telex printer, associated with the auxiliary device, or from another distant

subscriber. In either case, once the connection is established, two-way conversation on a half-duplex basis takes place between the auxiliary device and the remote location.

Control of Auxiliary Device

A Telex subscriber may control an auxiliary device from the local Telex station or from a remote location. This control cuts-in or cuts-out the auxiliary device from the Telex transmission. To cut-in after a Telex connection has been established, the operator depresses the IN button on the Crypto Data Plate, located on the front of the printer. Depressing the button energizes the Crypto Control, shown in Figure 1, and switches the auxiliary device from an off-line to an on-line condition. To cut-out the device after transmission is completed, the OUT button on the plate is depressed, and the auxiliary device is returned to an off-line condition.

To accomplish this IN-OUT feature from a remote Telex location, a pair of contacts are installed on the Telex set associated with the auxiliary device. These contacts close upon receipt of a selected single character from the remote location. The Crypto Control is energized and the auxiliary device is cut in. A message can then be sent from the remote location to the auxiliary device or vice versa. When the message has been transmitted, a Telex disconnect may be initiated. The Crypto Control is deenergized, and the auxiliary device is returned to the off-line condition.

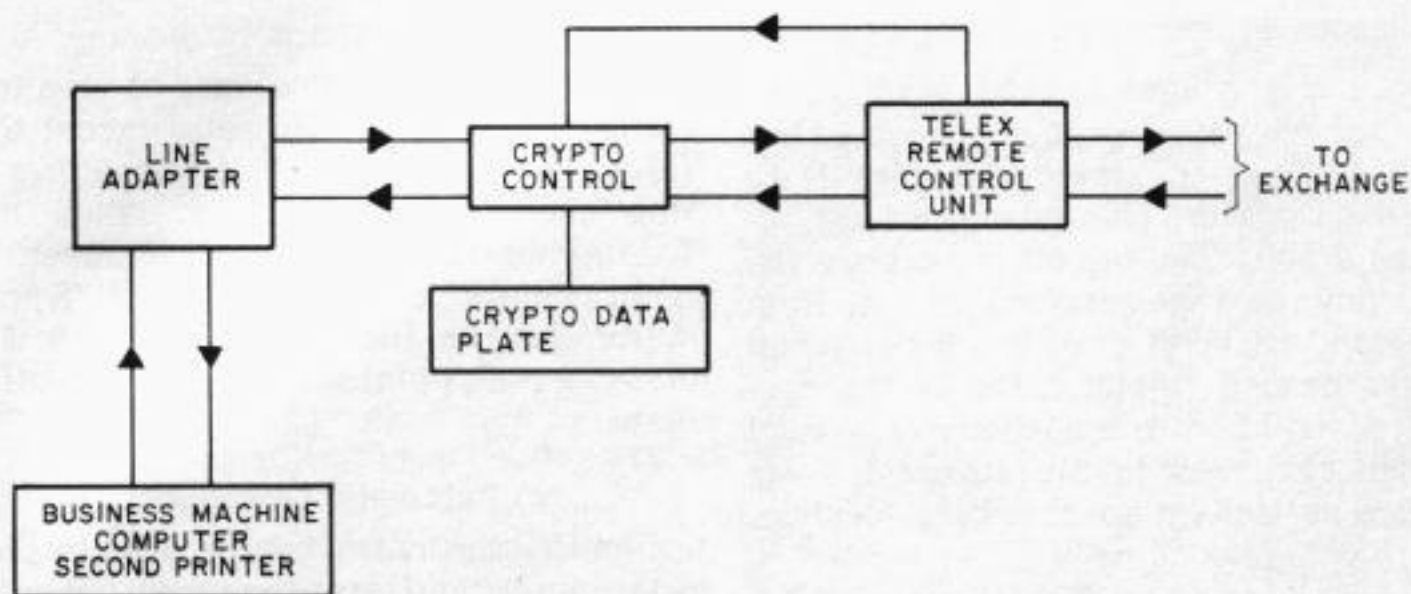


Figure 1. Equipment for Control of Auxiliary Devices

Control of Telex set

Certain control features are available on the Telex set when an auxiliary device is used.

a) When the Telex subscriber wishes to receive coded information, such as encrypted messages or data which may contain the upper case D character (who-are-you), a means must be provided to prevent the answer-back of the called subscriber from being tripped. Blind circuits are available on the Model 28 and Model 32 Telex printers to perform this function.

The answer-back blinding circuit is energized after the initial exchange of answer-backs, when a single character is transmitted to the receiving machine. After that, the reception of an upper case

D will not trip the answer-back.

By depressing the OUT button of the Crypto Data Plate, the blind circuit is released to allow a final exchange of answer-backs before disconnecting.

b) When a Telex subscriber wishes to send or receive information at a different speed or with a different format than that normally used, the printer may be blinded from copying any information. Crypto Control 11932-A and Crypto Data Plate 12422 are used for this option, with the Crypto Data Plate providing the manual control and visual indication of the blinded condition. The printer blind circuit can be cut-in either manually or on a single character selection.

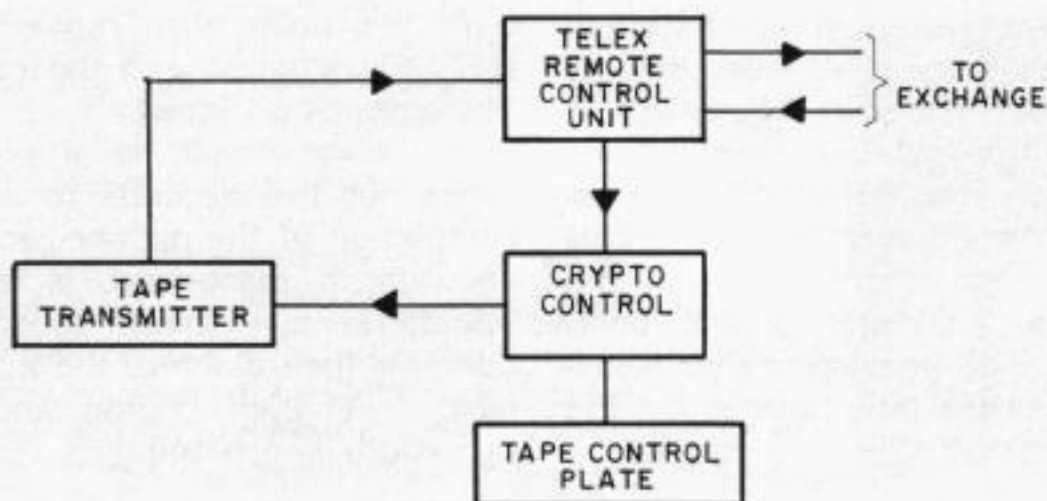


Figure 2. Equipment for Tape Transmitter Control

2) Second Printer

A second printer can be used as an auxiliary device, when it is connected via the Line Adapter, shown in Figure 1, to the Telex printer. This second printer operates exactly like any other auxiliary device. Any message received or sent from the standard Telex printer will be copied by the second printer. Also in the connected condition, the auxiliary or second printer can send to the standard Telex printer as well as to a remote location.

Tape Transmitter Control

The Telex ASR sets have a Tape Transmitter/Reperforator in addition to the printer. The Transmitter is used to send messages which have been punched on paper tape. The reperforator is used to prepare these punched tape messages, but it can also be used to make a tape copy of incoming messages. The control of the tape in the Transmitter may be accomplished at a local Telex station or at a remote Telex unit.

The Crypto Control may be used for Automatic Start, Automatic Stop or Automatic Disconnect.

The Control Plate is a supervisory unit and has two pushbuttons (IN and OUT), an indicator light and a switch for editing tape.

a) Automatic Start

The Transmitter of all Telex sets, except the Telex ASR Set 10661-A (Siemens T-100 Printer), can be started from a remote location upon receipt of a single character. This option permits reception of a message from an unattended station. When a station is to be unattended, the operator must throw the start-stop switch to the START position before leaving. When a Telex connection is established to this position from a distant location, the Transmitter will turn on upon receipt of the single selection character at the unattended station. The message is then transmitted and when the tape has run out the transmitter turns off.

b) Automatic Stop

Crypto Control can be used to stop the Transmitter of all Telex sets, except the Telex ASR Set 10661-A, by inserting a stop character in the tape. When the Transmitter reads this stop character, it is turned off automatically. The Transmitter may be turned on again, by depressing the IN button on the Tape Control Plate.

c) Automatic Disconnect

The Crypto Control can be used to provide automatic Telex disconnect when a tight-tape or tape-out condition is recognized. It automatically initiates the disconnect at the end of the message.

When a Telex printer is modified for this option, it is often desirable to disable the automatic disconnect feature, so that more than one tape can be sent or information can be added manually from the keyboard after the tape has been transmitted.

In order to disable the automatic disconnect feature, the Tape Edit switch on the control plate should be thrown to the EDIT position.

Multimessage Tape Transmission

In Multimessage Transmission a number of messages are punched on one continuous tape. At the end of each message, a FIGS D is punched. The destination for the first message is then dialed up and answer-backs are exchanged.

When the operator starts the Transmitter, the first message is transmitted in the normal manner until the first FIGS D is read in the tape.

At this point, the Transmitter is automatically stopped and the called party's answer-back is tripped.

A timing circuit, at the calling end, times out five seconds to allow for the completion of the answer-back. After five seconds, a disconnect is automatically initiated and an alarm is sounded. The operator then dials up the number of the next destination station and the same procedure is repeated.

A number of modes of operation are possible by combining two or more of the above Tape Transmitter Control options.

Automatic Dialer

The MAGICALL* Electronic Dialer, shown in Figure 3, is designed to eliminate manual dialing of each Telex number. Up to 1000 numbers can be stored on one continuous roll of magnetic tape. These recorded numbers are used to initiate a Telex connection.

The Automatic Dialer has a Dial-In-Unit and separate power supply not shown in the illustration of a typical installation in Figure 3. The magnetic tape on which the numbers are recorded is housed in a removable cartridge within the Dialer Unit. Numbers are recorded on the magnetic tape by means of the Dial-In-Unit. This unit is plugged into the main Dialer Unit **only** during the recording procedure.

In order to make a Telex call with the MAGICALL Electronic Dialer the operator must:

- 1) Locate the desired number between the guide lines of the dialer Unit.
- 2) Depress START button on the Telex Remote Control Unit and wait for the DIAL lamp on the Remote Control Unit to come on (Proceed to Dial signal).

* MAGICALL is the trademark for the Automatic Dialer manufactured by the DASA Corporation.



Figure 3. Automatic Dialers mounted on Telex Set

- 3) When the DIAL lamp lights the operator depresses the CALL button on the MAGICALL Dialer Unit. The dial digits of the subscriber being called are then generated into the Telex exchange by the Dialer Unit.
- 4) When a connection is made the Telex set is turned on in the normal manner.

PETER J. LAVITOLA, an Engineer in Information Systems and Services Department, has been concerned with the design and development of Outstation Equipment for Telex Subscribers.

Since he joined Western Union in 1964, he has assisted in the development of outstation equipment for GSA and with the design and development of the Second Answer-Back Unit for Teltex Receiving Positions.

Mr. Lavitola received his degree in Electrical Engineering from Manhattan College in 1964, and is currently doing graduate studies at Newark College of Engineering.



traffic recording

methods

—Emil Panzaru

In the Western Union's Telex System, a constant study of Telex traffic volume is used to ascertain whether the equipment is maintaining its predetermined grade of service. Grade of service is a measure of service quality and depends upon switching equipment available to a system. This grade may vary at any point in the circuit switching network. Therefore, knowledge of traffic flow pattern in the network is essential to provide a grade of service which is both economical in equipment layout and satisfactory to our customers. The theory of traffic analysis has been discussed in the TECHNICAL REVIEW, in earlier issues.^{1, 2}

The recording equipment used by Western Union in obtaining data on Telex traffic consists of Erlangmeters and Traffic Recorders as shown in Figure 1. However, in large Telex centers such as the TWM2 exchanges, a 12-Value Integrator replaces the Traffic Recorders.

Erlangmeter

The basic unit used in measuring the volume of traffic is the erlang, named after A. K. Erlang, a Danish expert on telephone traffic. One erlang of traffic is equivalent to one hour of uninterrupted seizure of a switching unit.³ Thus, if a trunk line linking two Telex exchanges is used con-

tinuously for one hour, the traffic volume measured at the trunk repeater is one erlang. In most cases, groups of trunks are used. If each repeater in a 20-trunk group is used for 30 minutes in a given one hour period, the Erlangmeter records 10 erlangs ($30/60 \times 20 = 10$). The Erlangmeter is a current integrating device similar to a watt-hour meter.

A schematic of the basic circuit in the Erlangmeter is shown in Figure 2. Erlangmeters are usually mounted on a traffic evaluation rack. This rack is used to interconnect the registration points of the switching units to traffic metering equipment.

The metering current per switching unit is approximately 30 ma. Thus each switching unit (repeater, switch, common control unit, etc.) contributes this amount of current during the period of seizure. The instantaneous sum of these currents is proportional to the momentary volume of traffic, to which the momentary rpm of the low impedance metering motor is proportional. This motor activates the 6-digit counter and, in conjunction with the auxiliary motor, it activates the pulse sender. The pulse sender is used with auxiliary metering equipment and its frequency is also proportional to the momentary traffic volume.

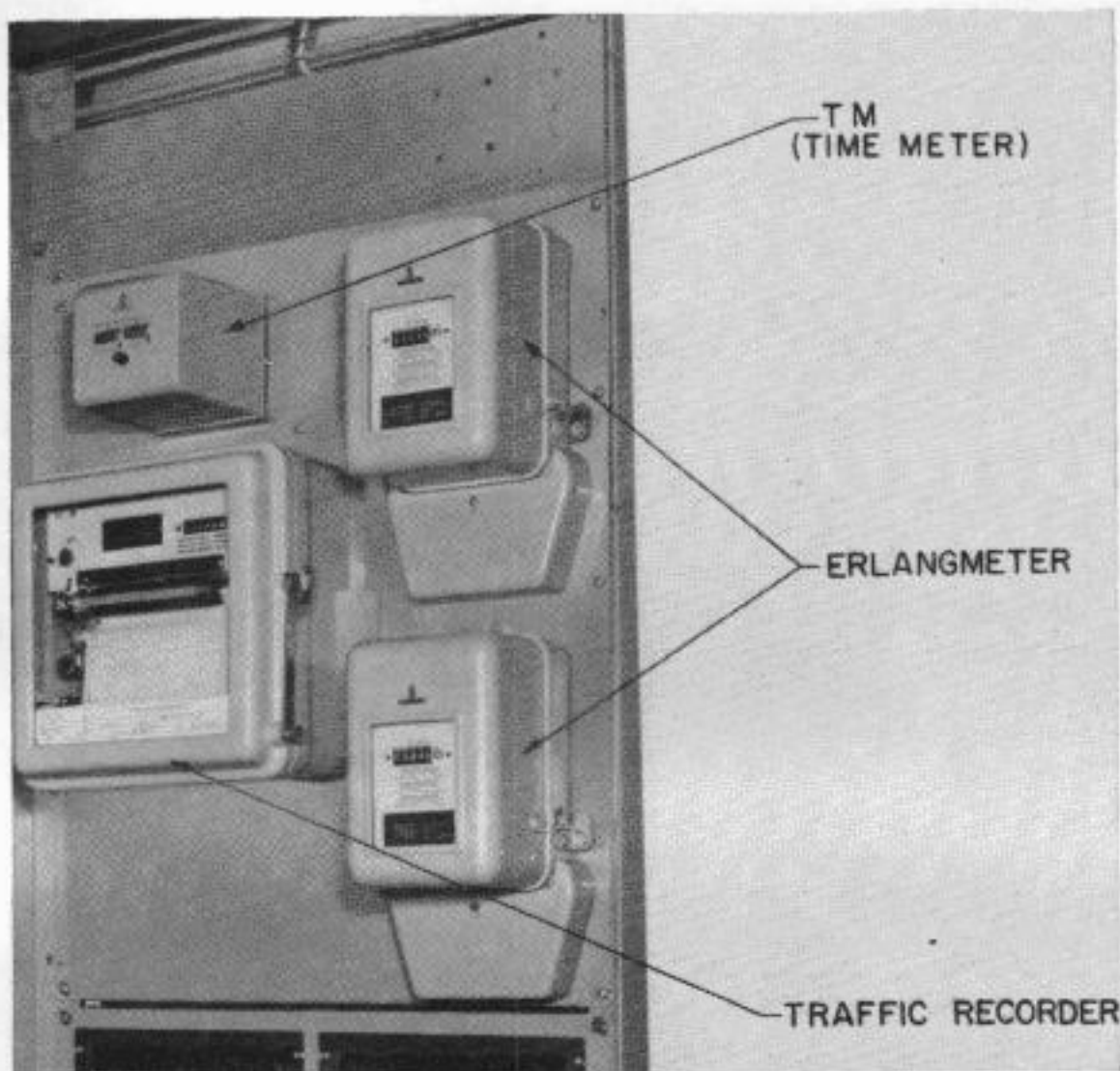


Figure 1. Mounted Erlangmeters, Traffic Recorder and Time Meter

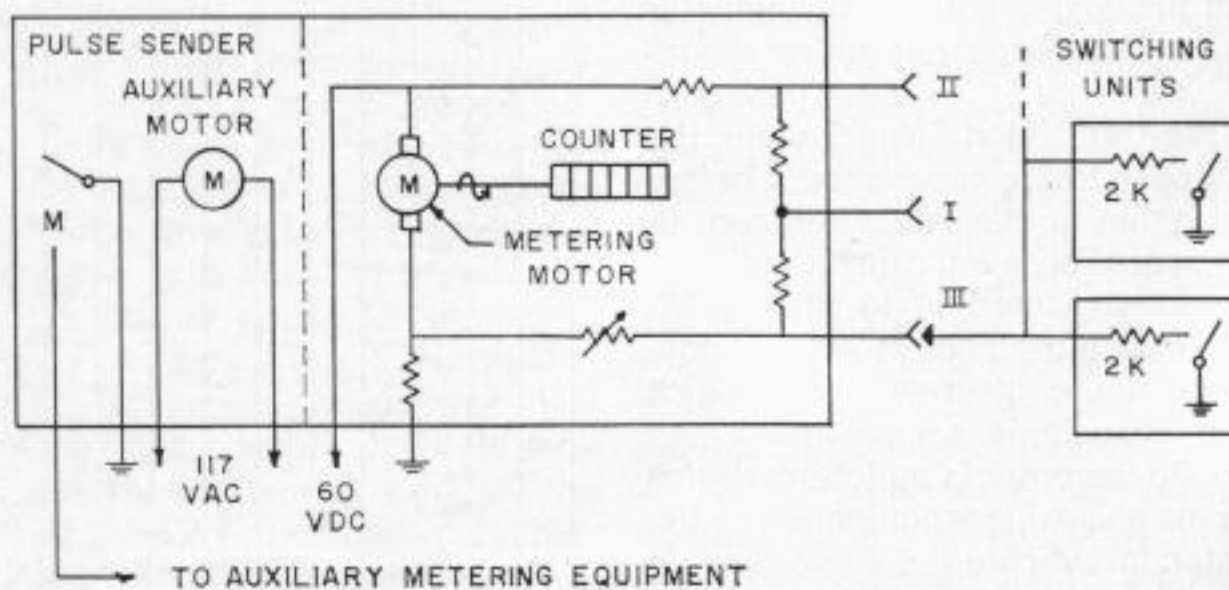


Figure 2. Schematic of Erlangmeter Circuit.

The number of switching units which may be measured by an Erlangmeter depends upon the measuring range of the Erlangmeter (inputs I, II or III). Each range has a corresponding range factor, specifying the Erlang/unit reading on the counter, and the Erlang/pulse emitted by the pulse sender. Table I shows the number of switching units which can be measured (metered) in each range.

TABLE I		
Measuring Range	Range Factor (erlang/pulse)	No. of Units Measured
I	0.1	5-100
II	0.5	25-500
III	0.02	1-20

The net change in the reading of the 6-digit counter, during a particular one-hour period, is multiplied by the range factor to obtain the traffic volume carried by a group of switching units.

For example, assume an Erlangmeter to be loaded with 20 trunk repeaters via range III. If the reading of its counter at the beginning of a given one-hour period is 071145, and that at the end of the period is 071545, the net change in the meter reading is 400. Thus $400(0.02) = 8$ erlangs.

Traffic Recorder

The cumulative data registered by an Erlangmeter is not sufficient, to determine the number of switching units, required in a given group to maintain a certain grade of service. This cumulative data has to be interpreted in terms of the peak traffic periods of the day; to use the Erlangmeter readings for this purpose is rather laborious.

In the Western Union Telex System, the periods of peak traffic occur shortly before noon and again in the late afternoon, in each time zone. These are called the "Busy Hour" periods. According to the CCITT, the Busy Hour must consist of four consecutive 15-minute intervals, during which the total traffic volume is a maximum.

The Traffic Recorder is a plotting device which serves as auxiliary equipment to the Erlangmeter to indicate the Busy Hour in any given 24 hours. Figure 3 is a sample graph from the Traffic Recorder.

As the recording paper advances downward, in step with the time-indexed left margin a stylus deflects to the right, printing one dot for each received pulse. The stylus returns left to its starting position, every 15 minutes.

Each pulse causes a 0.2 millimeter deflection. Thus, the total deflection in any 15-minute interval depends upon the number of pulses received during this interval. By inspection, one can determine the Busy Hour by selecting the four longest consecutive lines on the graph as indicated in Figure 3.

The total horizontal length of these lines in millimeters is used to find the number of Erlangmeter pulses generated during the Busy Hour. This number is multiplied by the appropriate range factor on the Erlangmeter to establish the traffic volume in erlangs.

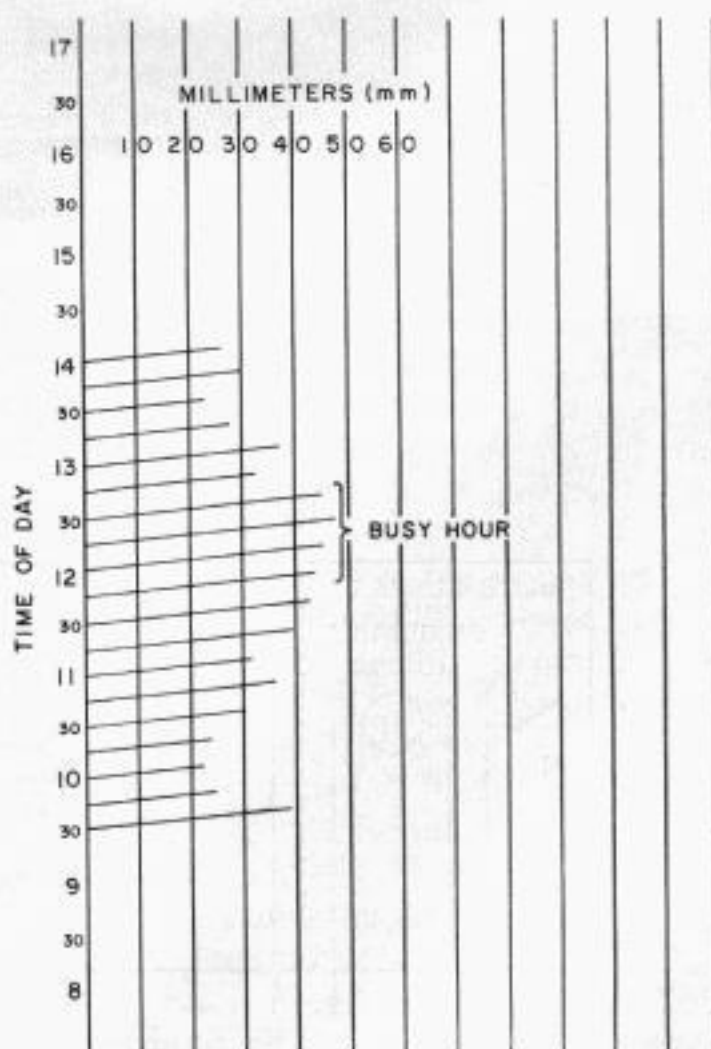


Figure 3. Sample Graph from Traffic Recorder



Figure. 4. 12-Value Integrator

12-Value Integrator

Large Telex centers, such as the TWM2 Exchanges, contain many groups of switching units which often require simultaneous metering. Since the Erlangmeter-Traffic Recorder method described above becomes rather time consuming for large exchanges, the 12-Value Integrator is used. Figure 4 shows two adjacent 12-Value Integrator racks. The page printer, shown on the right, connects to either rack and its receive function is part of the operation of the 12-Value Integrator.

This integrator collects, stores and records periodically, Telex traffic data generated by as many as 12 Erlangmeters.

These Erlangmeters may be located in a central TWM2 Junction Office or in a remote Telex center serving as district to the junction. In either case, the Erlangmeter pulses are continually stored and counted in 12 storage counters. Each counter serves one Erlangmeter. The number of pulses stored by each counter during a 15-minute period is processed by a scanning device and fed to a page printer. Thus, the printer produces a new recording every 15 minutes. At the end of each recording, all counters return to zero. Consequently, the printer records only the pulses stored in a particular 15-minute interval. The Time and Date unit defines this interval.

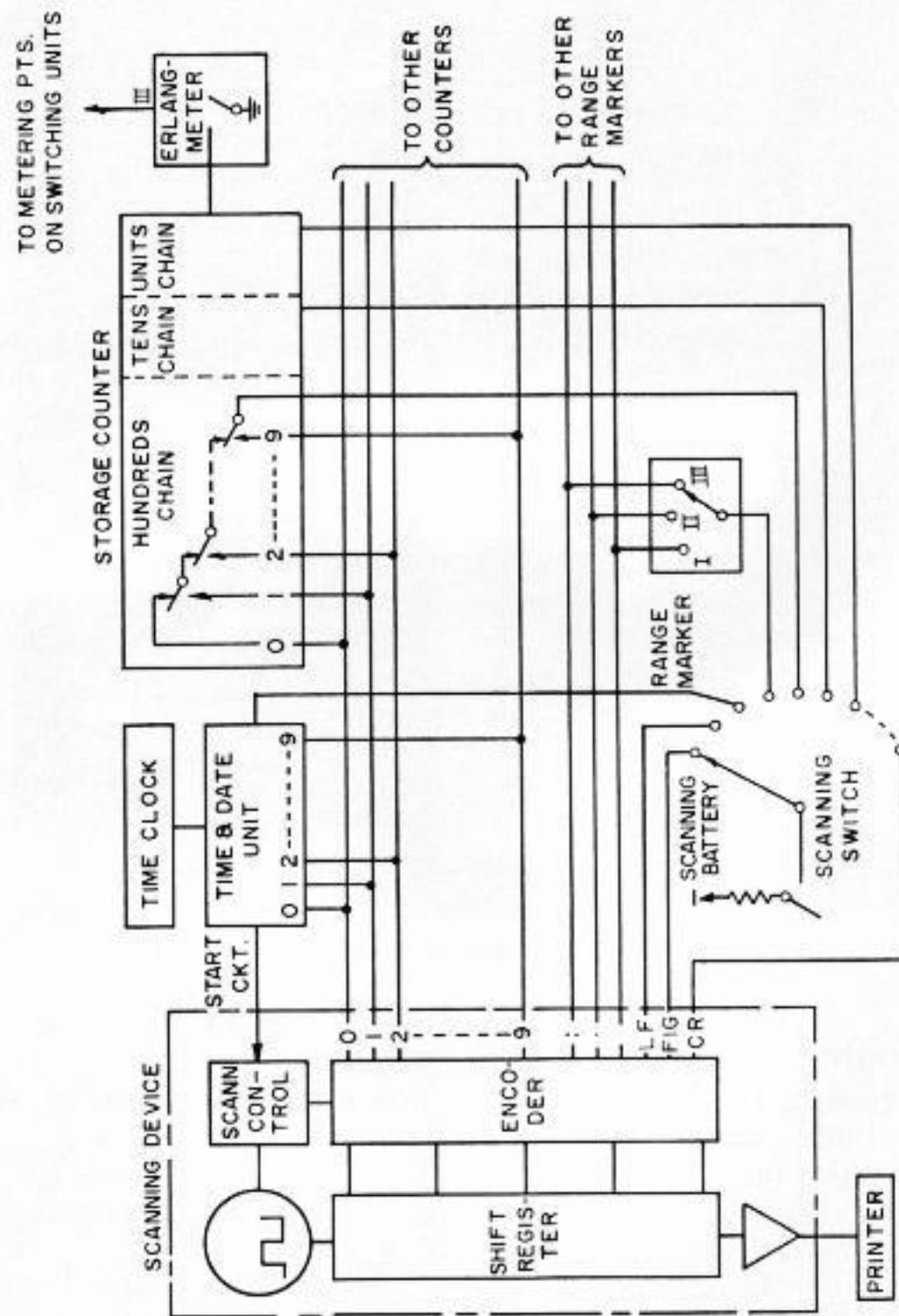


Figure 5. Simplified Scanning Circuit

Scanning Circuit

Basic to the operation of the 12-Value Integrator, is the Scanning Device. The simplified scanning circuit is shown in Figure 5. This scanner consists of a shift register which performs a "parallel-to-series" conversion, an Encoder which serves to load in parallel, the five binary stages of the shift register, and a Scanning Control section. When a negative potential is applied to any one of 16 loading terminals on the Encoder, the shift register feeds out a teleprinter character, corresponding to the symbol on the terminal. The output of the shift register is applied to an amplifier, which provides a 50-baud, make-break circuit for the associated page printer.

The Storage Counter (one of 12) consists of three counting relay chains. The pulse sender of an Erlangmeter is coupled to the units-counting chain. The capacity of the Storage Counter is 999. The contact network of the hundreds-counting chain is shown in detail to illustrate how the scanning battery is returned to the Encoder.

The Time and Date unit is activated by clock pulses generated by a master time clock, at a frequency of one pulse per minute. The unit consists of four selectors which perform the registration of minutes, hours, days and months.

During registration, the wipers of these selectors also provide a loading path to the Encoder. The Time and Date unit issues a start pulse to the Scanning Device every 15 minutes.

The scanning process simply involves the stepping of the scanning switch in a predetermined sequence, whereby the wiper returns the negative battery to the Encoder. The range marker is a manual switch, which indicates the range used on the Erlangmeter. Thus, every 15 minutes, the printer produces a record showing the date and time of the record, plus the number of pulses stored by each Storage Counter during a particular 15-minute interval.

Page Printer Recording

Figure 6 is a typical page printer copy of three recordings.

The first three columns on this page copy, indicate Office Code, Date and Time of Day respectively.

Following the "time of day" information, the remaining columns represent the readings from the 12 respective Storage Counters. Each column displays the traffic load carried by a particular group of switching units for a $\frac{1}{4}$ hour period. At the end of one day, the Busy Hour in any column is determined by selecting four consecutive numbers in the column of

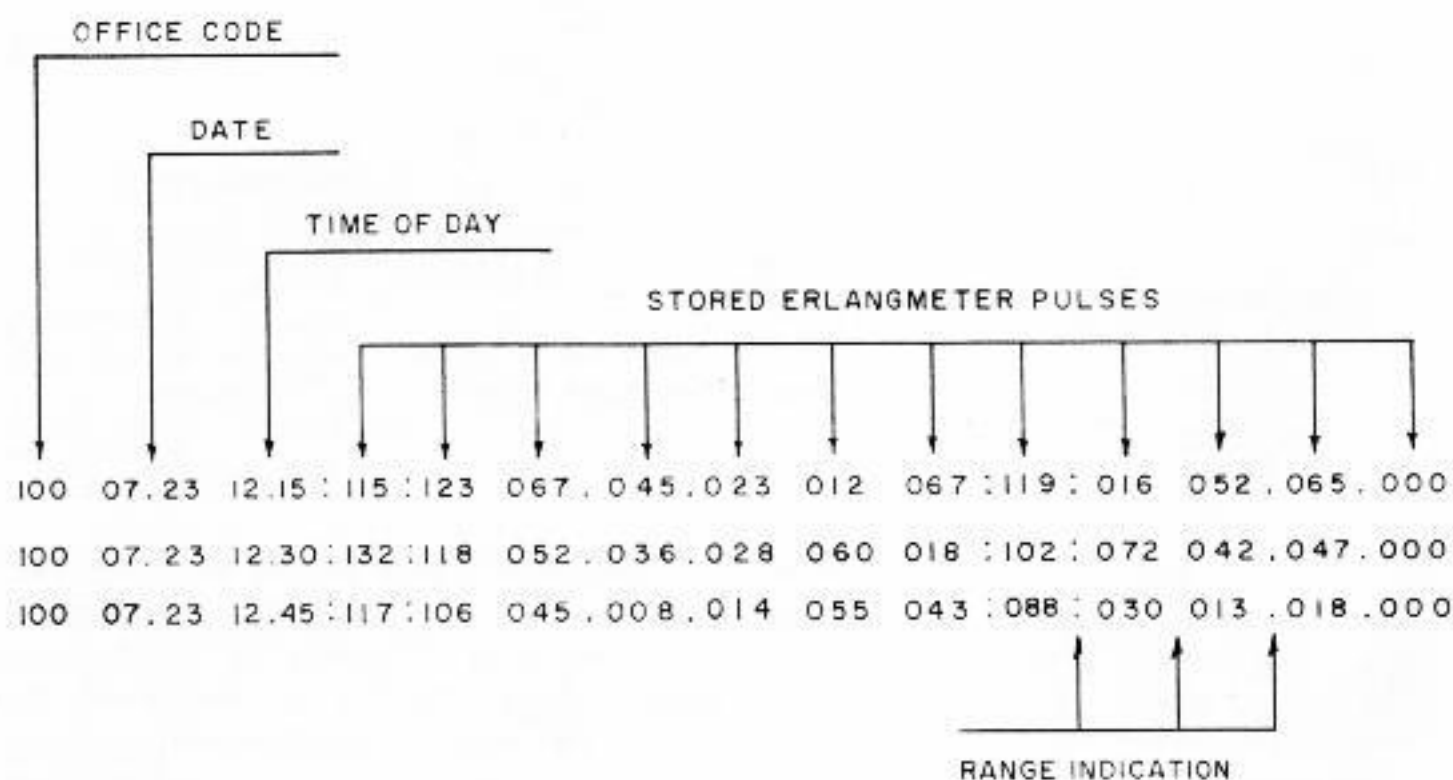


Figure 6. Typical Page Printer Copy

interest, such that their total is a maximum. This total number is then multiplied by the corresponding range factor to establish the load in erlangs. A space, dot or semicolon, preceding the numbers, indicates the operating range of the Erlangmeter serving the particular group of switching units. (Range I—space; Range II—dot; Range III—semicolon.) The office code is used to indicate the office where the traffic is being measured. In this particular illustration, the 100 code identifies the New York Junction exchange.

Recording from District Office

A Telex junction exchange may have a number of peripheral Telex centers, serving as District Offices. In order to centralize the recording of Telex Traffic, the traffic data measured by means of Erlangmeters in a district exchange is transmitted to the Junction Office and recorded by means of the 12-value Integrator. The transmission process makes use of the pulse-storing property of an Erlangmeter and the start-stop function of its pulse sender. This pulse sender can be stopped and started by the auxiliary equipment, without interfering with the metering clock of the Erlangmeter. When the pulse sender is stopped, the next six pulses are stored in a mechanical

to auxiliary equipment at a constant frequency (100 ms pulse: 400 ms interval). Once the mechanical storage is depleted, the frequency of the pulse sender is again determined by the instantaneous traffic load.

A specially designed repeater in the distant exchange serves as auxiliary equipment to a maximum of 12 Erlangmeters. This repeater is subject to pushbutton control from the control panel of the 12-Value Integrator in the central TWM2 exchange to which it connects by means of a trunk carrier. Thus, upon request from the central exchange, this repeater collects the stored pulses from the Erlangmeters and transmits them in block form to the 12-Value Integrator. The transmission principle is similar to time-division multiplex and is controlled from the 12-Value Integrator.

More specifically, the sending repeater periodically requests that each Erlangmeter releases one pulse from its mechanical storage, by controlling the start-stop operation of all pulse senders simultaneously. This permits a parallel transfer of pulses from the storage of the Erlangmeters to the sending repeater. In the sending repeater, each transferred pulse is momentarily stored and positioned in a scanning circuit, in preparation for serial

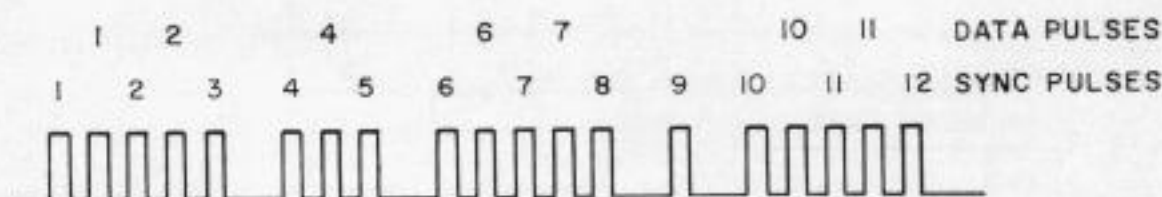


Figure 7. Transmitted Pulse Train

storage device, within the Erlangmeter. (Under maximum load condition and for any metering range, the pulse sender may be stopped for about 20 seconds at a time, without loss of pulses.) When reactivated, the pulse sender reads off the stored pulses and sends them out

transmission. Once this is accomplished, the repeater causes all pulse senders to stop, while it proceeds to send out a pulse train containing an equivalent data pulse for each Erlangmeter pulse collected during the pulse transfer time. The position of a data pulse in the

transmitted pulse train identifies a particular Erlangmeter in the distant Exchange. Each data pulse is 50 ms in length and is preceded by a 50 ms sync pulse. If only some of the 12 Erlangmeters have pulses in storage when the repeater requests a pulse transfer, data pulses may be missing from the transmitted pulse train, as shown in Figure 7.

If none of the Erlangmeters contain at least one pulse in storage when the sending repeater requests a pulse transfer (a condition existing during low-traffic periods), the repeater waits until one of the 12 Erlangmeters in the distant exchange can send out one pulse. Thus, each transmitted pulse train contains at least one data pulse.

Once a pulse train has been transmitted, the process repeats itself, and the repetition rate (approx. 2.6 per sec. per pulse train) prevents the Erlangmeters in the distant exchange from overloading their mechanical storages.

In the central TWM2 office, the receiving repeater associated with the 12-Value Integrator suppresses the sync pulses (used only for control of time-division), and passes the data pulses to the 12 Storage Counters. The position of a data pulse in the received pulse train determines the counter upon which the respective pulse is stored. Thus, an Erlangmeter pulse generated by the first Erlangmeter in the dis-

tant exchange (each Erlangmeter is assigned an individual send-position with respect to the sending repeater) causes the first Storage Counter in the 12-Value Integrator to receive and store an equivalent data pulse. The scanning and recording process of this data is identical to the one described above for the local traffic. The office code tabulated in Figure 6, identifies the district exchange where the traffic load was measured.

Thus, all traffic data measured in a District Office (DO) can be recorded in an associated junction office.

Presently, plans are being considered to use the perforator attachment on the ASR set serving the 12-Value Integrator to obtain traffic recordings on tape, as well. Thus, at the end of a day, the tape can be fed into a computer which is programmed to spell out the Busy Hours for a particular recording period. Furthermore, all junction offices may transmit their traffic recordings to a computer center, where the analysis of Telex traffic for the entire system can be made.

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EMIL PANZARU, Engineer in the Information Systems and Services Department, assisted in Telex Traffic Evaluation Study for the expansion of Western Union's Telex Network.

His major assignment is in the applications and system design, using TWM2 equipment. He has done extensive studies on various types of Traffic Evaluation equipment. Recently, he was responsible for the design of a Translator, used in the Type 600-A, Automatic Four Wire Switching System. This system serves the National Aeronautics and Space Administration (NASA).

Mr. Panzaru joined Western Union Telegraph Company in 1955.



telex interface

for use with

computers

—Earl C. Mansfield

Because computer "on line" and "real time" systems are being offered to many geographically separated users simultaneously with the growth of common carrier circuit switching systems a need developed for an interfacing arrangement which would permit the interconnection of the two types of systems. This article describes one such interfacing arrangement currently being used in the Western Union Telex system.

The Telex Interface is used to interface a single Long Distance subscriber Exchange line with a computer. The Interface may be mounted in the pedestal of a standard Model 32 Telex Set, shown in Figure 1.

This Interface not only permits the computer to automatically initiate calls to Telex subscribers but also allows the subscribers to send messages to the computer. The layout and the interconnections between the various units within the Interface is shown in Figure 2.

The Interface permits isolation of the computer from the Telex Exchange, as shown in the schematic diagram of the signal path, in Figure 3.

At present the model 32 KSR or ASR set can be provided with an Interface. In addition to housing the Interface, the Model 32 is used for:

- a) Off-line testing of the computer lines and programs, as an alternate means of communication with the Telex Sys-

tem during computer down-time

- b) Answer-back of incoming calls which is important in automatic Telex system testing
- c) Maintenance testing with the Telex Exchange.



Figure 1. Model 32 Telex Set with mounted Supervisory Panel

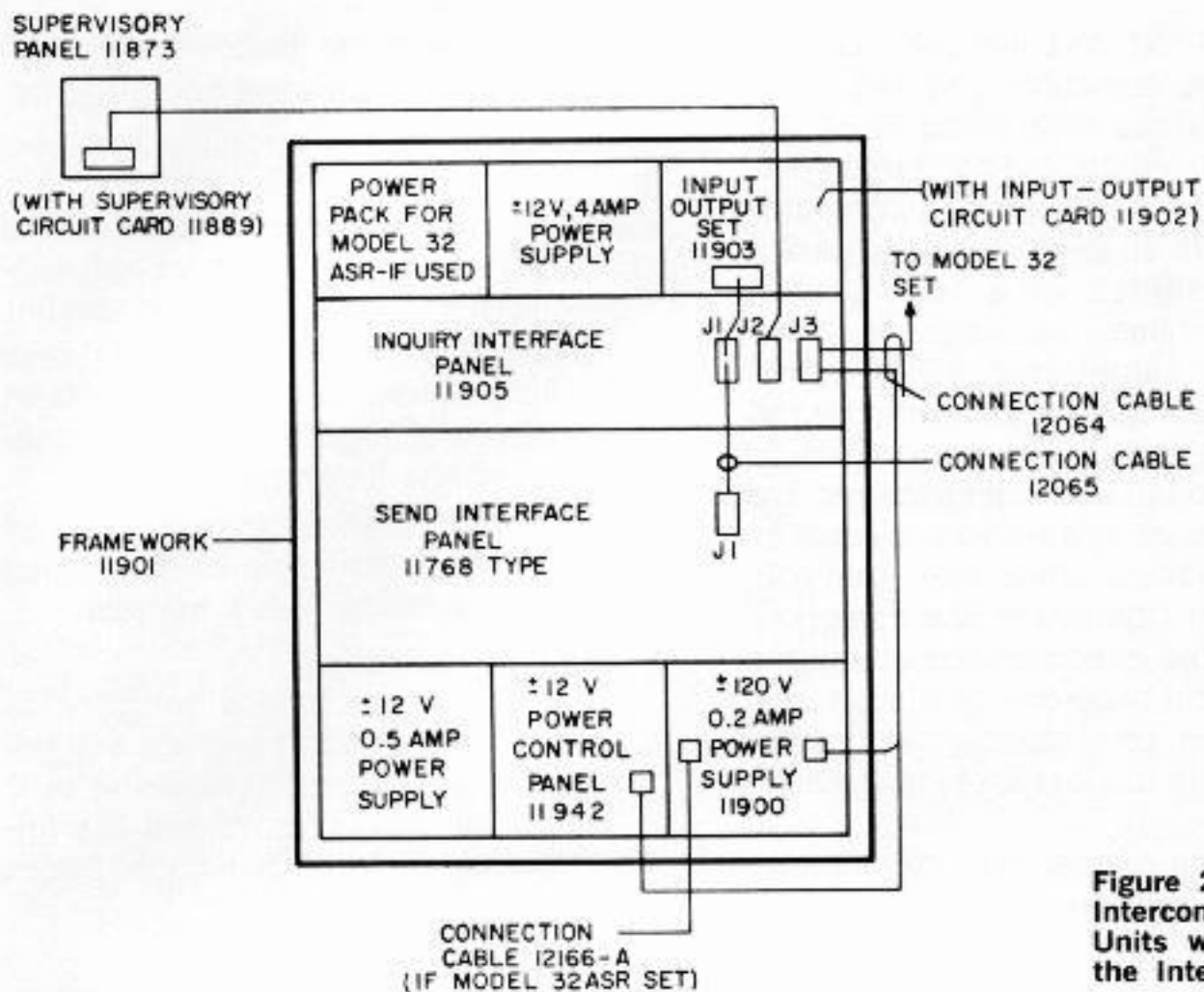


Figure 2.
Interconnection of
Units within
the Interface

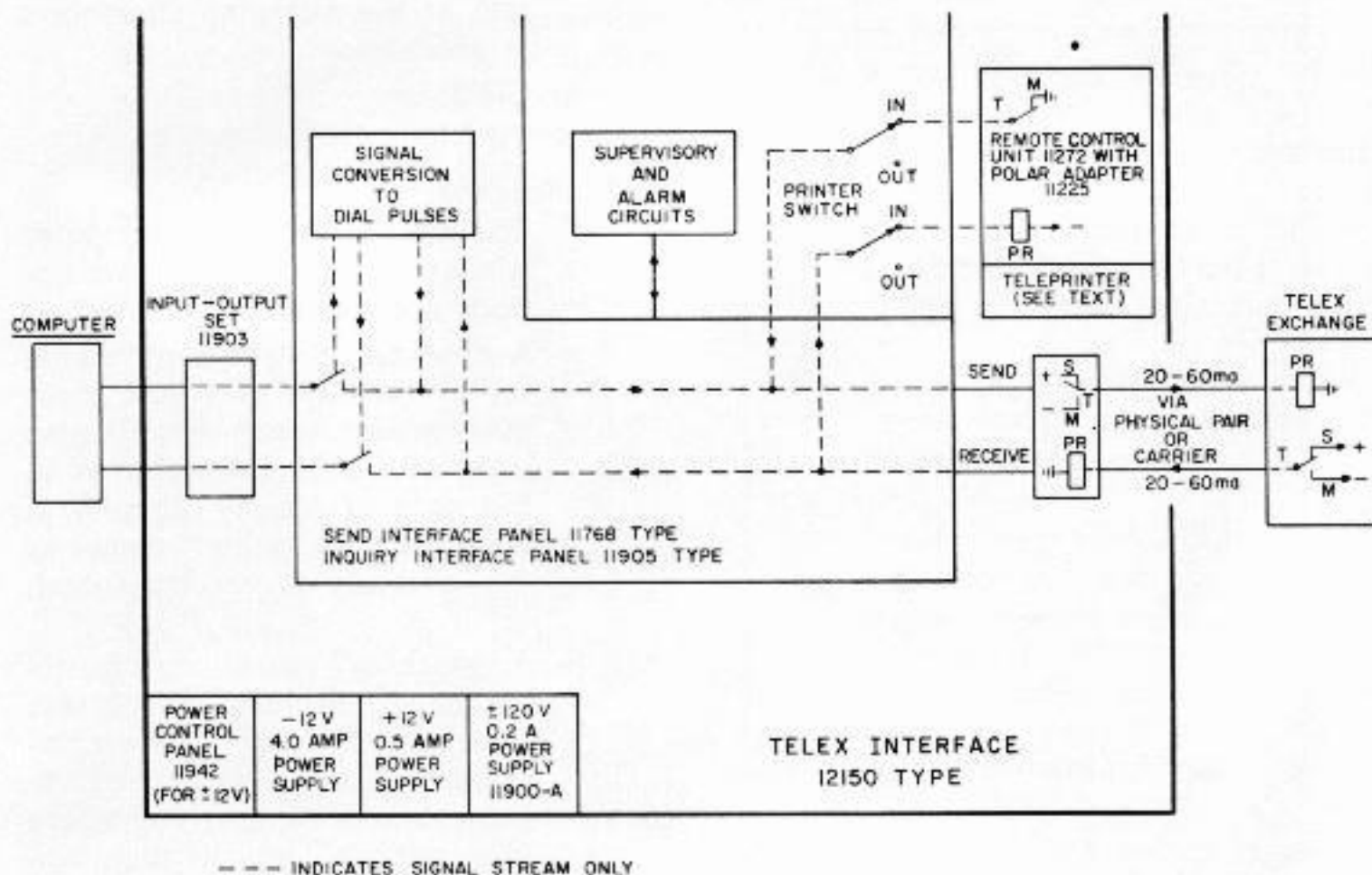


Figure 3. Schematic Diagram of Signal Path from the Computer to the Telex Exchange

Input-Output Set #11903 connects the Interface to the computer and the Telex Exchange. A layout of the set is shown in Figure 4. It is connected to the computer on a 2- or 4-wire basis. The computer send and receive circuits may be separate or may be connected as a loop. Control signalling and line transmission takes place via the same lines. Line transmission is serial by bit and character, at a speed of 50 bauds (66 wpm) in a 5-level Baudot code. The computer receive line or loop circuit is held in a closed or "marking" condition while idle. Controls are provided for "blinding" the computer lines. In the blind condition the computer receive line or the loop can be placed in a permanent open or "spacing" condition or in a permanent closed or "marking" condition.

The resistance of the computer receiving element should be held to less than 500 ohms; the inductance to less than 0.5 henries.

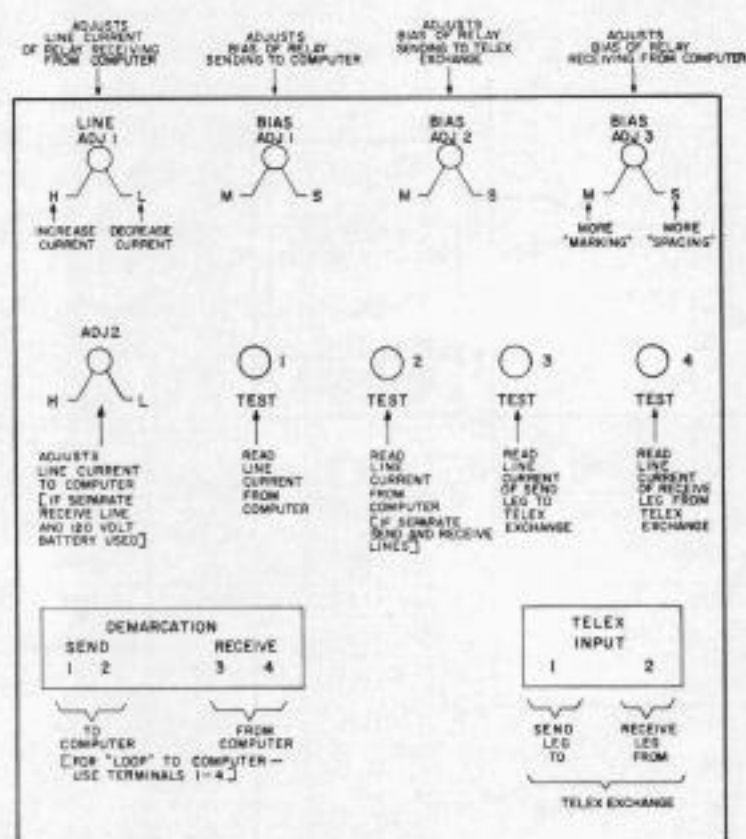


Figure 4. Input-Output Set

When the computer is connected with the Interface, the following operating options are available:

- 1 Call Request
 - a- The first character transmitted is first digit of the called subscriber's Telex number, or
 - b- Send a sequence of lower case characters, followed by FIGS and the first digit of the called subscriber's Telex number, or
 - c- Send a single character, followed by the first digit of the called subscriber's Telex number.
- 2 End of Selection

To indicate that a selection is complete and to prevent any additional pulses from being sent to the computer, one of the following End of Selection Codes must be used:

 - a- Space, or
 - b- Z.
- 3 Confirmation of Connection

To confirm to the computer that a connection to the called subscriber has been established, one of the following characters is available:

 - a- LTRS, or
 - b- "V"
- 4 Disconnect

To indicate that the computer wishes to disconnect, two options are available:

 - a- A continuous "spacing" signal for a minimum of 1 sec. However, when the computer is also used with a Line Adapter as in the case of Inquiry Circuits, a continuous "spacing" signal of 2.5 seconds is recommended, or
 - b- A "marking" condition, adjustable to a maximum of 40 sec. However, this is only recommended in cases where the computer is sending only and where idle periods, which may approach a Disconnect interval, are not anticipated.

Supervisory Panel

Three alarm conditions are indicated on the Supervisory Panel shown mounted on the right of the Telex set in Figure 1 when failure to receive the proper signal exists. These alarms are activated as follows:

DIAL ALARM—This lamp is lit when a "Proceed to Select" signal from the Telex Exchange is not received within 40 seconds after a Call Request is initiated. Normally, this indicates that trouble exists between the Interface and the Telex Exchange, (such as an open on the send or receive line). This alarm is automatically cleared if the computer initiates another call and is connected. This alarm can be manually cleared by depressing the LOGIC RESET and ALARM RESET buttons on the Panel.

BUSY—This lamp is lit when the computer fails to send the next digit within the allotted time after a Present Next Digit (PND) pulse or if a BUSY condition occurs in the Telex system. This alarm can be automatically or manually cleared. It is automatically cleared when the computer initiates another call and makes a connection. It is manually cleared by depressing the LOGIC RESET and ALARM RESET buttons on the Panel.

CONN ALARM—This lamp is lit if within 40 ± 4 seconds after the 1st PND pulse is sent to the computer no "Call Connect" signal or BUSY signal has been received by the Interface.

The alarm can be automatically reset by the computer initiating, and completing a new call, or manually by depressing the LOGIC RESET and ALARM RESET buttons.

Two switches are located on the Supervisory Panel; one for the Printer and the other for Test.

PRINTER—This switch cuts the Telex set in and out. When the switch is in the

IN position, the Model 32 Telex set, equipped with a set of parts, will be turned ON by a CALL CONNECT signal. The Printer switch must be in the IN position during computer downtime to provide identification or answer back to a calling subscriber.

When the switch is in its OUT position, the Model 32 Telex set will be off and will not respond to a "CALL CONNECT" signal. Consequently, no monitoring takes place.

TEST—The Test switch has three positions: COMPUTER BLINDED, NORMAL and LOCAL SEND.

a) **COMPUTER BLINDED**

When the Test switch is in the COMPUTER BLINDED position, the COMPUTER BLINDED lamp is on indicating the computer cannot send or receive calls. The associated Telex set can receive calls and send messages to any regular subscriber in the Telex system. This test checks the printer operation and the facilities to and from the Telex Exchange.

b) **NORMAL**

The Test switch is usually in the NORMAL position. When the Printer switch is in the IN position, the Telex set will copy all messages to and from the computer. Test messages may be monitored, maintainers may talk back and forth, circuits may be "lined up" and signals may be adjusted between the computer, the Telex set and the Telex Exchange.

c) **LOCAL SEND**

With the Test switch in the LOCAL SEND position and the Printer in the IN position, the computer can be tested for its incoming call sequence. The outgoing call sequence can also be checked from the point equivalent to a regular CALL CONNECT condition.

When the Test switch is in this position, the LOCAL SEND lamp is lit.

How a Call is Made

Figure 5 is a Flow Chart of the various steps in initiating a call from the computer:

1 IDLE

The computer checks to insure that the termination is idle. This indicates that no incoming call is requested, that the Send and Receive lines have been closed or are in a "marking" condition, for at least 2 seconds, and no other call is being set up from that terminal.

2 Call Request

The computer calls the Telex subscriber by transmitting the first digit of his number, at 50 bauds, in a 5-level 7.5 unit Baudot code, using one of the options mentioned previously.

3 Proceed to Select

The Interface reads only code combinations corresponding to digits. It does not read upper or lower case printed characters. When the Interface reads the first digit in Baudot code from the computer, the digit is stored and a call is made to the Telex Exchange.

(Call Request signal is a battery reversal on the send leg from the Interface to the relay in the Telex Exchange. Battery reversal is called "marking" when it goes from positive to negative potential. This negative potential is a marking condition.)

When the Telex Exchange recognizes the call signal, it returns a "Proceed to Select" signal to the Interface. The Interface converts the stored Baudot digit to dial pulses

and transmits the dial pulses to the Telex Exchange.

(When the dial pulses have been transmitted, a 600 ms "marking" signal is sent to the Telex Exchange. This signal is known as Interdigit Dial Time.)

4 Present Next Digit (PND) to computer

At the beginning of the above Interdigit Dial Time interval, the computer receives a 20 ms "spacing" pulse, a PND pulse, which is equivalent to the start pulse of a LETTERS character in the Baudot code.

Two interface configurations permit a variation in the allowable response time of the computer to the PND pulse. The basic unit allows a maximum delay of 380 ms. The second version allows a delay of approximately 3 sec.

5 Sends 2nd Digit

The computer reads the PND pulse and "sends the next digit" in the called Telex subscriber's number.

6 Receives 2nd PND Pulse

When the Interface recognizes that the 2nd digit has been converted to dial pulses and sent to the Telex Exchange, a second PND pulse is sent to the computer.

7 Sends 3rd Digit and Subsequent Digits

The computer transmits the 3rd digit and the subsequent digits within the allotted time after each PND pulse.

(If this time is exceeded, the Interface sends a signal to the Computer to disconnect and the BUSY lamp on the Supervisory Panel lights.)

8 Receives Last PND Pulse

After the computer sends the remaining digits in the called Telex subscriber's number, it sends the

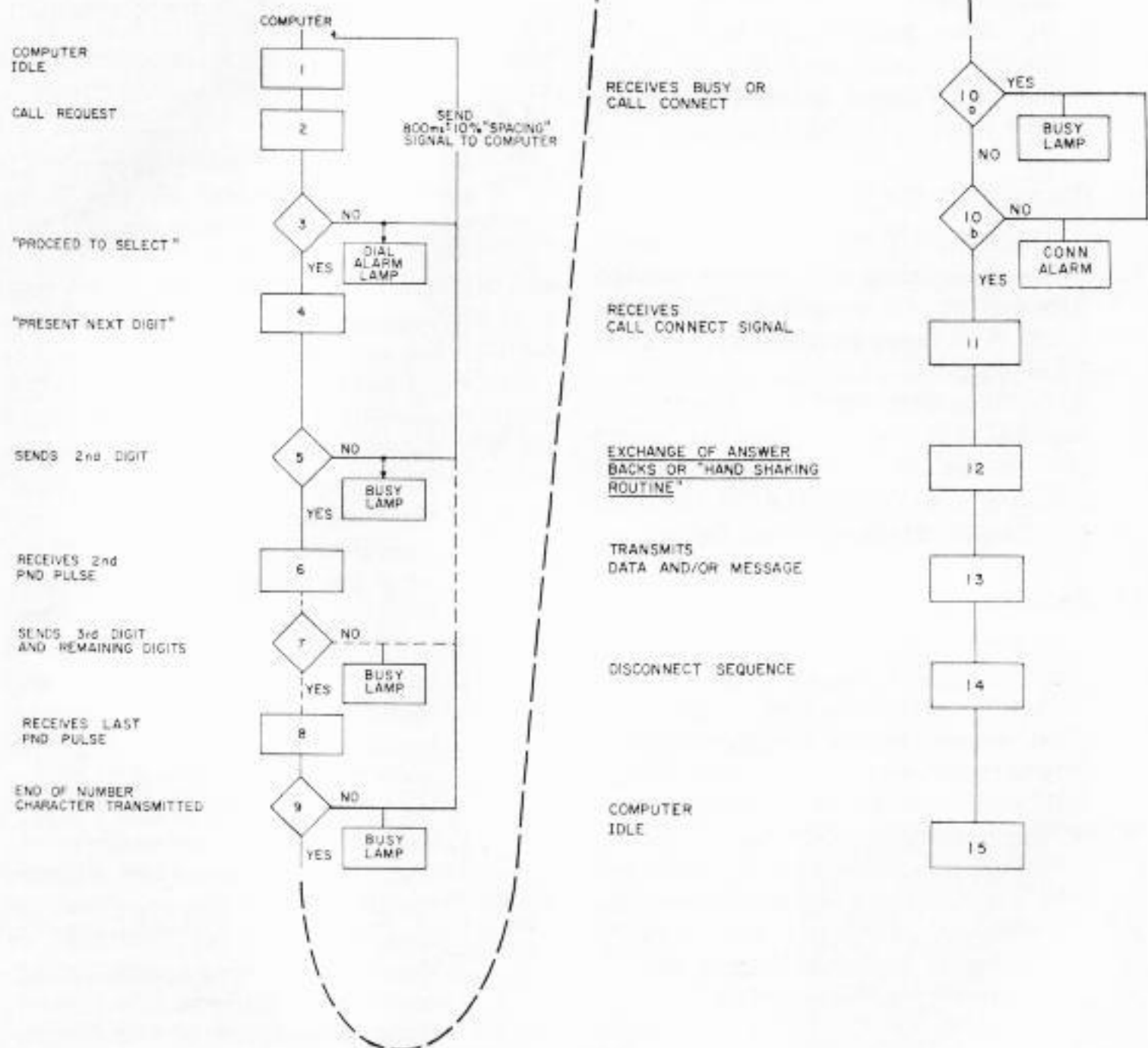


Figure 5. Flow Chart Showing Steps in Initiating a Call from a Computer

End-of-Number EON character, within the allotted time after the PND pulse following the last digit of the number.

(If this time is exceeded, the computer is disconnected and a BUSY lamp on the supervisory Panel lights.)

9 Sends EON Character

When the computer sends the EON, End of Number character, all further PND pulses to the computer are suppressed.

No other signals are sent to the computer until a BUSY or CALL CONNECT signal is sent to the Interface from the Telex Exchange.

10 Receives BUSY or CALL CONNECT

A BUSY or CALL CONNECT condition must occur within approximately 40 sec of the leading edge of the 1st PND pulse received by the computer.

(If neither condition occurs, an 800 ms "spacing" signal is sent to the computer to disconnect and the CONN ALARM lamp on the supervisory Panel lights.)

11 Receives CALL CONNECT

If the called Telex subscriber is available, a CALL CONNECT signal (permanent "marking" condition on receive leg of the Interface) is recognized by the Interface.

After 2 seconds, the Interface transmits a V character to the computer. The V character read by the computer indicates the called Telex subscriber is connected and is ready to receive. The CONN lamp on the Supervisory Panel lights.

12 Exchange of ANSWER-BACKS

The computer now engages in its routine for the exchange of ANSWER-BACKS. Prior to transmitting the WRU sequence, FIGS D, a single preselected character, preferably upper case, is sent by the

computer to deactivate the answer-back of the Model 32 set associated with the Interface. The WRU sequence is now sent to activate the answer back of the distant Telex set.

13 Transmits Data or Message

When the exchange of ANSWER-BACKS is completed, data or message transmission between the computer and the Telex subscriber takes place on a half-duplex basis. Either the computer or the Telex subscriber can transmit, but not simultaneously.

14 Disconnect

When the transmission is completed, either the computer or the Telex subscriber can disconnect.

a) By Computer

If the computer initiates the Disconnect, it holds its send line continuously "spacing" or holds its loop circuit open from 1 to 2.5 seconds. When separate send and receive lines are used between the Interface and the computer, the receive line will continuously space from 200 ms to 800 ms after the computer starts its continuous "spacing" signal. When the 1 to 2.5 second "spacing" is completed, the computer will monitor its send and receive lines, or loop circuit for 2 seconds of steady "marking" before initiating another call.

b) By Called Telex Subscriber

If the Called subscriber initiates the Disconnect, the computer receive line goes on "spacing" or the computer loop opens for approximately 900 ms.

Upon completion of the Disconnect, the computer must monitor its loop or its send and receive legs, for at least 2 seconds of steady "marking" before initiating another call.

15 IDLE (same as 1)

Operational Guidelines

The following points should be considered for smooth operation of the Interface with the computer.

The 2-second idle line test is used as a guard against the computer attempting to initiate a call if a line or power failure has occurred, and also insures that the previous connection to the Exchange has been completely cleared.

The computer should be capable of re-assembling a message upon recognition of any failure during selection or transmission.

The computer should be programmed to take supervisory action if any call fails more than a predetermined number of times.

Continuous polling should not be used. If any polling is done, it should be done only on a pre-programmed basis. This permits normal usage of the Telex sets, and also allows the Telex stations to deliver priority data to the computer.

The approximate busy hour traffic load for the computer should be known. This insures that a good grade of service can be maintained, both for the computer, and for other subscribers in the same group.

Auxiliary Equipment

On Model 32 Telex sets, a set of parts #505022 are included to permit blocking of the answer-back and prevent the set from responding to the WRU sequence FIGS D.

This set of parts is required when the computer generates a FIGS D to get the answer back from a called Telex subscriber or when a Telex subscriber calls the computer and initiates the answer back by transmitting FIGS D to the computer, or when a FIGS D appears in the data transmission.

Acknowledgements

This article has been composed with the assistance of Brian M. Smith, who was instrumental in the logic, electronic design and testing of the Telex Interface.

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Mr. Mansfield has assisted in the development of some international systems. In 1956, he worked on Switching System 23-A for the Canadian National Telegraph Co. More recently he helped set up a semi-automatic overseas Telex System for Western Union International, Inc. He designed and developed Interface arrangements to permit Western Union International, Inc. operation with both manual and automatic TWX (D-TWX).

Mr. Mansfield received a BA degree in Liberal Arts and a BS degree in Electrical Engineering, from Columbia University in 1954.

He is a member of the IEEE and is associated with the professional groups on Electronic Computers, Communications Technology and Systems and Cybernetics.



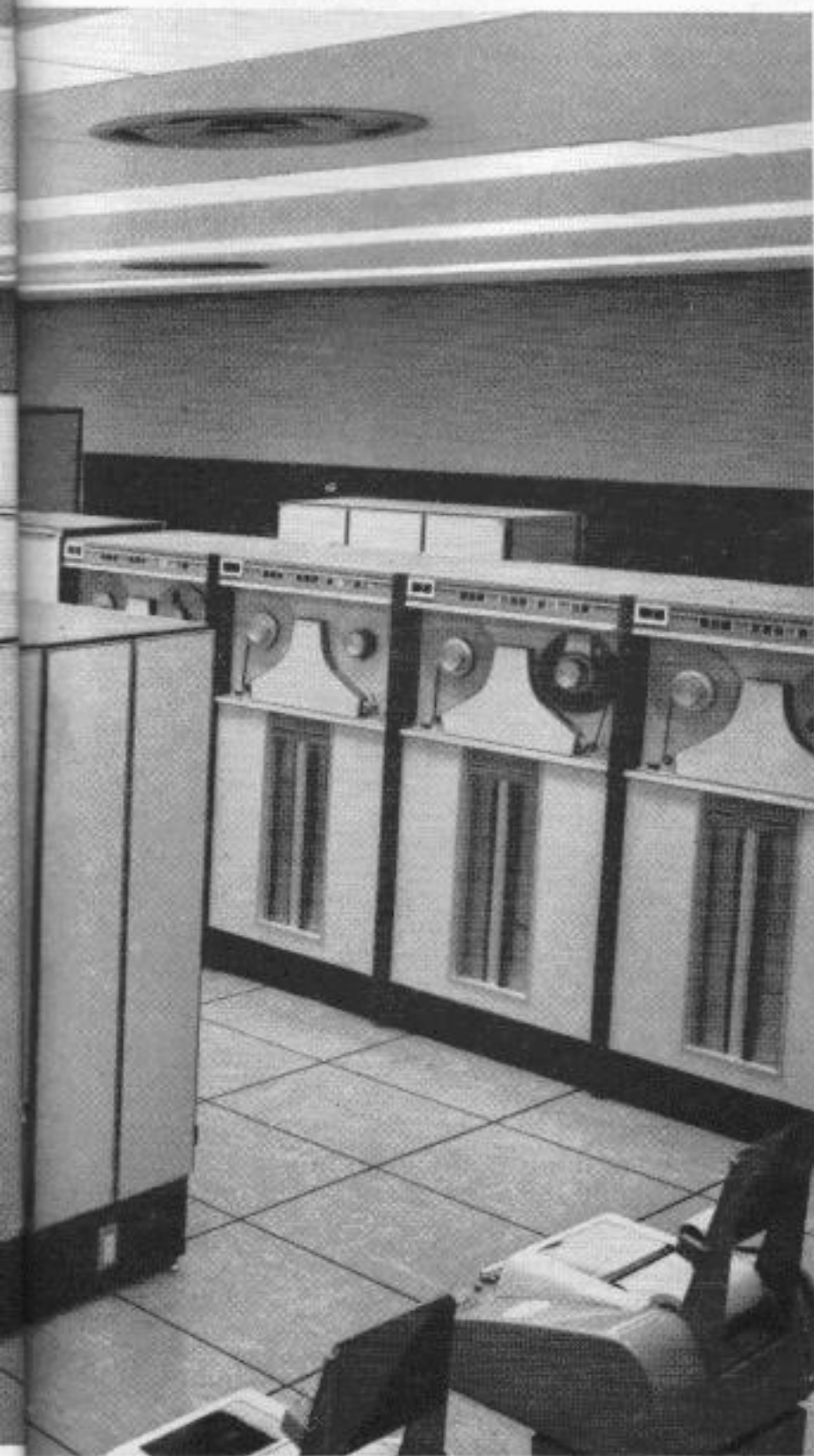
information services

computer center

—Sergio Wernikoff



Figure 1. Computer Center at W. U. Headquarters



60 Hudson St. New York City

Western Union officially inaugurated its first, real-time public service computer center linked with its coast-to-coast Telex system in December 1965.

The new Information Services Computer Center marks the beginning of the company's transition into a national information utility, which serves the information service needs of business and government.

This first center shown in Fig. 1 located at Western Union Headquarters 60 Hudson St., in New York City, serves thousands of customers through the Telex network. More computers are planned for other centers at key cities.

Designed to provide a variety of new Info-MAC (Information Multiple Access Computer) communication and information services, the computer center began officially serving about 1,500 Telex customers in eight Eastern cities and now has increased this service to 3,000 customers since May 1966. Computer-center service for all Western Union Telex customers nationwide is scheduled for operation and will serve more than 16,000 United States Telex customers.

The program calls for the ultimate integration of the public message network consisting of company-owned and operated computers using high-speed data channels at key cities. The integrated Telex-public message network will combine maximum flexibility, speed and accuracy.

Services of the Center

The services presently offered through the ISCC are known as Automatic Computer Telex Services (ACTS) and Info-Mac Services. ACTS provide Telex subscribers with the ability to transmit messages on a store-and-forward basis to:

- a. AT&T's TWX subscribers equipped with unattended operation and unique answer-back in the continental United States, except Alaska.
- b. Telex subscribers anywhere in the continental United States, except Alaska; also in Canada and in Mexico; and
- c. Up to 100 Telex and/or TWX subscribers, in any combination, who should receive the same message text.

These services overcome some of the limitations inherent in systems which only provide circuit switching capabilities, such as Telex or TWX.

Telex-to-TWX

The first service, Telex-to-TWX, is designed to overcome the incompatibility of two nationwide circuit switching networks.

Previously, there were two communities of subscribers, those of Western Union's Telex network and those of AT&T's TWX network. Subscribers of one network could not use their station equipment to communicate with subscribers of the other network. With the Telex-to-TWX relay service in the ISCC, Telex subscribers can now transmit messages to one or more TWX stations. The restrictions that TWX subscribers be equipped with unattended service and unique answer-back are imposed for message protection.

Although only a small percentage of the TWX subscribers are presently equipped with these features, the number is continually increasing.

Telex-to-Telex

The second service, Telex-to-Telex, is designed to overcome the problem arising from busy stations in a circuit switching network. Let us assume three stations are connected to one network. Anytime subscriber A calls subscriber B, there is a probability that subscriber B is busy with a connection to subscriber C. The only way subscriber A can transmit his message is to continue trying to place his call, until he finds the line of subscriber B idle. This process is inefficient for both the subscriber and the equipment. Now, with the ISCC, when subscriber A encounters a busy signal, he may dial the computer center. Since a large number of trunks exist between the computer and the circuit switching network, the probability of encountering a busy signal is considerably less. Therefore, subscriber A has a much greater chance of transmitting a message on the first call to the computer center. The ISCC will, at periodic intervals, attempt to automatically transmit the

message. Each time the ISCC encounters a series of three consecutive busy signals, it waits three minutes prior to re-initiating the delivery procedure. This latter feature minimizes the use of the circuit switching network equipment for calls that cannot be completed.

Multiple Address

The third service, Telex-to-Multiple-Telex and/or TWX addressees, is designed to overcome the point-to-point nature of circuit switching networks. Some networks provide for conferencing capabilities so that several subscribers of a circuit switching network can be connected simultaneously. This is impractical for many requirements because of the long set-up time required for conference calls, and the problems arising when one station is busy or out of service. Generally, a circuit switching network is used to establish an electrical path between two stations. In order to overcome this limitation, a Telex subscriber, wishing to transmit the same text to more than one subscriber of the Telex and/or TWX networks, may now dial the ISCC once and transmit the message including all addressees. The ISCC will then automatically transmit the message to each addressee. Privacy is maintained, because each addressee receives only his portion of the address section of the message.

Legal Citation Service

In addition to the Telex oriented services described above, the first Info-MAC, called the Legal Citation Service (LCS), has been introduced. LCS will be offered by Law Research Services, Inc. using Western Union's facilities.

The LCS is an on-line information retrieval service. The user can rapidly and accurately have access to the latest references of precedent setting legal cases for a large number of points of law. For each inquiry that the user transmits to the ISCC, he receives all the applicable references for a maximum of ten cases, plus an indication if there are more cases on file referring to that particular point of law. The

cases are arranged in chronological order, with the most recent cases always the first to be transmitted to the user. This service reduces the research time of lawyers and others involved in judicial cases. It also provides most recent information, which is not usually available, for a considerable time after a law decision has been handed down.

Automatic Computer Telex Services

When a Telex subscriber wishes to use any of the ACT services described above, he dials "1040," the number for the computer center. When he is connected with the computer, the ISCC sends the following identifying message:

WU ISCC	07/18/66	123456	(Figs D)
Computer Center Identification	Date	ISCC Internal Message Number	Request of Calling Subscribers' Answer-back

When the subscriber's station receives the (Figs D) sequence, its answer-back is automatically activated. Following this exchange of answer-backs, the subscriber may now proceed to transmit his message. The originating subscriber's message must be transmitted in a pre-established format which is illustrated in Figure 2. Every message must contain the following control signals:

- The Start of Message (ZC<≡)
- At least one valid routing line
- The End of Routing signal (.)
- The Beginning of Text Signal (<≡BT<≡)
- The End of Message Signal (NNNN)

legend { carriage return <
line-feed ≡ }

```

Line 1: ZC<≡
Line 2: TLX 12081 W U ISCC NYK <≡
        TWX 2018431005 W U SYST ENG PAR.<≡
Line 3: TO 12081 COMPUTER CENTER PERSONNEL <≡
Line 4: BT <≡
Line 5: MESSAGE TEXT
Line 6: NNNN

```

carriage return <
line-feed ≡ } legend

Figure 2. ISCC MESSAGE FORMAT

Line 1: ZC<≡ is the Start of Message

Line 2: These are the routing lines. "TLX" indicates the addressee is a Telex customer; the number which follows is the Telex number of the addressee, and the characters following the number are the addressee's answer-back. "TWX" indicates that the addressee is a subscriber of AT&T's TWX network; the number is the TWX number of the addressee and the characters following the number are the addressee's answer-back. The period (.) preceding the carriage-return line-feed of this line is the "End of Routing" symbol and the last routing line.

Line 3: This line allows the originating subscriber to add secondary information, so as to facilitate delivery of the message at the destination station. The Telex number is repeated so that this secondary information can be correlated with the proper routing line.

Line 4: The sequence "BT" or Beginning of Text indicates the end of the secondary routing information, as well as, the start of the information to be transmitted from the originator to the destination.

Line 5: The text of the message starts on line 5. The following characters (ZC<≡), (Figures D) or (NNNN) cannot appear in the message.

Line 6: This line is the end of message sequence and it consists of four consecutive "N" characters (NNNN).

As the message enters the computer, the computer program checks it for all the control signals. In the case of routing lines, the computer only checks that the information appears generally correct. In Telex messages, it checks to be sure that the subscriber's number is four to eight digits in length. The computer program also checks for characters following the number, which are generally accepted as the answer-back characters.

If all checks are met, the computer transmits the following acceptance message to the calling subscriber:

ACCEPTED WESTERN UNION INFORMATION SERVICES COMPUTER CENTER

If all the checks are not met, the computer will automatically transmit a rejection message, indicating which control sequence was omitted. For example, if the originator of the message accidentally omits the "Beginning of Text" sequence, the ISCC sends the following service message:

UNABLE TO PROCESS—NO BEGINNING OF TEXT PLEASE CORRECT AND RESEND WESTERN UNION INFORMATION SERVICES COMPUTER CENTER

Following the transmission of the acceptance or rejection message, the ISCC will initiate a disconnect signal, as only one message is permitted per connection.

When the ISCC program recognizes that it has received a valid message, and before it has completed the acceptance message to the originator, the computer initiates the steps to transmit the message.

If the addressee of the message is a Telex subscriber, as in the above example, the computer checks for an idle output trunk. The computer seizes the trunk and as soon as it receives a "Go Ahead" from the Telex exchange, it transmits the dial digits to the Telex exchange via the Telex interface unit. If the called subscriber is idle and the computer receives a "Call Connected Signal", the ISCC waits for two seconds to allow the subscriber's motor, to come up to speed, and then transmits the "Who Are You?" signal (Figures D). The

"Who Are You?" signal will automatically activate the answer-back of the called subscriber. This answer-back, when received by the computer, is compared with the one that appeared in the routing line. The comparison is made on the basis of all printing characters, with the exception of the "Space" character. If the answer-back comparison is correct, the computer will initiate transmission of the message to the addressee, and will send the following pre-message header:

VIA WU ISCC	07/18/66	123456
Computer Center Identification	Date	ISCC Internal Message Number (Assigned When Message Entered the System)

Following this header, the computer transmits only the address portion for this particular addressee plus the complete text of the message.

At the end of transmission, the computer again requests the answer-back of the station for confirmation that the message was received by the addressee. Should a disconnect occur after the transmission was initiated, or if the computer does not receive the answer-back requested at the end of the transmission, the ISCC will automatically re-dial the subscriber and add to the message a "suspected duplicate" notice.

If the call was placed via an output trunk and a busy signal was encountered, the ISCC will attempt twice more to deliver the message. If after the third attempt, the subscriber is still busy, the computer center will place the message in a "Busy Table" and wait three minutes before attempting delivery. This process is continued for one hour. If a message remains within the system over that length of time, the message with an indication of the unserved routing lines are sent to the Output Intercept position. If the answer-back of the called station and that of the routing line does not check correctly, after three successive attempts, the message is also transmitted to the Output Intercept Position.

A message is only sent to the Output Intercept Position once, with all the unserved routing lines indicated by special code. Figure 3 is a typical print-out of a troublesome message at the Output Intercept Position.

```

Line 1: 095314 0001227
Line 2: R TWX 123456789 ABC CORP <≡
Line 3: A TLX 12281 CCC CORP NYK<≡
Line 4: U TLX 278991 BBB CORP CGO<≡
Line 5: ZC<≡
      TLX 125581 ISCC-SPD NYK <≡
      TWX 123456789 ABC CORP <≡
      TWX 2018431005 DEF MNFG CO<≡
      TLX 12281 CCC CORP NYK<≡
      TLX 278991 BBB CORP CGO.<≡
      BT<≡
      TEXT
Line 6: NNNN
Line 7: AB

```

**Figure 3. A typical PRINTOUT
ISCC Output Intercept Position**

Explanation

- Line 1:** The time that the message is being delivered to the Output Intercept Position and the Original Message Number assigned when the message first entered the system.
- Line 2:** The "R" indicates that the routing Line is incorrect. In this case the reason it is incorrect is that the TWX number only has nine digits instead of the required ten.
- Line 3:** The "A" indicates that the answer-back in this routing line does not check with the one of the station when that particular Telex number is called.
- Line 4:** The "U" indicates that the system has been unsuccessful in delivering the message to the addressee due to always receiving a busy signal for the maximum period of time that a message is allowed within the system.

Lines 5-6: The original message as it entered the ISCC.

Line 7: Output Intercept Position answer-back, which assures the ISCC that this position is operational.

At the present time, the TWX deliveries are handled on a torn-tape basis. Therefore, if the computer recognizes that it has a TWX delivery, it immediately seeks an idle Model 28 ASR set used for TWX relay positions. At these positions, the messages appear on both "hard-copy" and printed perforated tape. The tape is punched in 5-level TWX code rather than the Telex code. Thus, the generated tape is used to transmit directly from standard 5-level TWX stations leased from AT&T under that company's tariffs. At the end of the transmission of a message to a TWX relay position, the ISCC requests the answer-back from the relay position to check that the relay position is operative. Arrangements are presently being made with the appropriate Bell System operating companies so that in the expanded system this transfer to the TWX network will be on a fully-automatic basis.

During the output processing of messages, the first-in first-out rules are maintained for each class of service.

If a station is busy, delivery is delayed until it is available. Deliveries depend on the number of trunks connected to the computer at any given time. Since each delivery over a particular output trunk is independent of other output trunks, the other output trunks may be occupied with deliveries of the same message to different addressees or handling completely different messages.

Anytime that the ISCC detects an abnormality, such as a subscriber starting to transmit a message and then disconnecting, fault errors, bad answer-back comparison output, busy signals, etc. it automatically transmits a coded message to the high-speed printer. This message indicates to the operating personnel the time and type occurred, the trunk number over which it occurred and information regarding the originator—if it was an input error, or the addressee—if it was an output error.


```

Line 1: LCS-
Line 2: 0000000602
Line 3: 1456772464
Line 4: 0000001056
Line 5: 0000001061
Line 6: ?
Line 7: 0000000005.
Line 8: WESTERN UNION LEGAL CITATION SERVICE
Line 9: 0000000602
Line 10: FRANK256 NYS2D 189, 45 MISC2D 171
Line 11: GENER257 NYS2D 120, 45 MISC2D 451
Line 12: TACA 256 NYS2D 129, 15 NY2D 97, 204 NE2D 329
Line 13: JAY S256 NYS2D 600, 15 NY2D 141, 204 NE2D 638
Line 14: 1456772464
Line 15: CITATION SET UNAVAILABLE
Line 16: 0000001056
Line 17: PHIL1234 NYS2D 948, 37 MISC2D 150
Line 18: ATLAN195 NYS2D 820, 20 MISC2D 390
Line 19: ALLEN153 NYS2D 779, 1 AD2D 599, REVERSED 161
      NYS2D 418, 2 NY2D 534, 6
Line 20: ALR2D 1309, SCHWA221 NYS2D 917, 31 MISC2D 768
Line 21: 0000001061
Line 22: INVALID INQUIRY DESIGNATOR
Line 23: END

```

Figure 4. A typical PRINTOUT for the Legal Citation Service

Explanation

Line 1: This is the service designator for the Legal Citation Service and consists of "LCS-".

Lines 2-5: These are the inquiry numbers for which the customer is requesting citation cases.

Line 6: This is the "End of Inquiry Designator".

Line 7: This is the Charge Number. Each user is assigned a charge number for billing purposes, similar to a credit card number.

Line 8: This is initial response from the ISCC identifying the service.

Lines 9-22: These are the originator's inquiry number repeated plus the response. Note that all the inquiry numbers that can be serviced are serviced. In the case of errors, Lines 14 and 21 different messages are sent to the user to facilitate his reaction.

Line 23: The word "END" is transmitted followed by a disconnect signal. In this way the customer knows that the ISCC has reacted to all his inquiries.

Legal Citation Service

In the case of the Legal Citation Service, the customer calls the ISCC and the computer responds in the same manner as described above. The calling subscriber then enters his inquiry in the format shown in Figure 4. Every inquiry must contain:

- a. The Start of Message (inquiry) LCS-
- b. At least one valid inquiry number
- c. The end of inquiry signal (?)
- d. A valid charge number

The inquiry service is recognized by the "Start of Message" sequence characters, LCS-. Upon recognition of this sequence, the ISCC analyzes each inquiry number to be sure that it passes the mathematical checks. After receipt of the "End of Inquiry" (?) sequence, it checks the charge number. Having completed all the checks, the ISCC then automatically initiates the retrieval of the legal citation cases from its mass storage. The response is transmitted to the originating subscriber on the same call; that is, the computer does not call-back the originator in order to send the replies to the inquiry numbers.

If a subscriber sends a mixture of correct and incorrect inquiry numbers to the center, the ISCC will service all those that are valid and will indicate to the customer those that are incorrect. A typical printout for an LCS inquiry is shown in Figure 4.

If the customer sends an invalid charge number, the ISCC will not service any inquiries, but will transmit the following message:

```

WESTERN UNION LEGAL CITATION SERVICE
INVALID CHARGE DESIGNATOR

```

When the inquiry has been serviced, the computer will automatically originate a disconnect signal.

Data is recorded on the UNIVAC Fast-rand II mass storage drum by means of an off-line program. Law Research Services, Inc. prepares the original data on punched cards and then transfers it to magnetic tape. The reels of magnetic tape are then read into the Fastrand drum by a special program that is designed to obtain the maximum efficiency of the storage capacity available.

Hardware

The ISCC consists of two complete systems; an on-line system to handle traffic and an off-line system to de-bug new programs and for fall-back. Each system consists of:

a. A Univac 418-II Computer, equipped with storage for 65,536 (18-bit) words, a 2-microsecond memory cycle, a console typewriter and an alarm. The computer stores programs required to validate message headers, to perform dialing procedures, to check answer-backs, to read-write from the drum, to write records on magnetic tape, to interface with the communications lines, etc.

b. A magnetic tape sub-system consisting of a controller, power supply and four magnetic tape units. Tapes may be written at any of three densities, 200-, 556-, or 800-characters per inch with transfer rates of 27-, 71-, or 102 kc respectively.

Five different types of records are maintained on magnetic tape. These tapes are the Reference, Input, Output, Error and LCS Journals. The Reference Journal is a complete copy of every message that enters the system. The Input Journal is a record of the header of each message, and the time required to receive the header and text portion of the message. The Output Journal is a record of each delivered message. The Error Journal is a record of every abnormality encountered by the ISCC, while accepting or transmitting a message. The LCS Journal is a record of every inquiry.

In addition, the tape stations are used to read in the program each morning, as well as to store special off-line programs, such as billing and message retrieval and recovery.

c. A fast-access magnetic drum, the Univac FH-330 Drum, is used to store special programs, which can be called in from the computer console and for the storage of messages while they are in-transit. Approximately 2,000 messages may be stored on the drum. When a message is completely processed, its location on the drum becomes available for another message. The drum has a capacity of 262,144 (18 bit) computer words. Each word may

be accessed in about 7.5 milliseconds.

d. The multiplexer is basically the interface between the computer and the communication lines. A communications multiplexer will be capable of accommodating 32 full-duplex lines of 2400 bits/seconds. It is presently equipped to handle 30 full-duplex lines, each capable of operating at speeds up to 300 bits per second. Each line may operate at any speed and code. Bits are received serially, stored to form a character and then transferred in parallel to the computer. The reverse process exists on output.

e. A Univac 1004-IA printer/card reader operates at 200 lines/200 cards per minute. The printer section is used mainly for on-line reports to the operating personnel, the same information recorded in the Error Journal, and for off-line reports such as billing. The card reader is used mainly during the de-bugging of the program, and also to enter corrections.

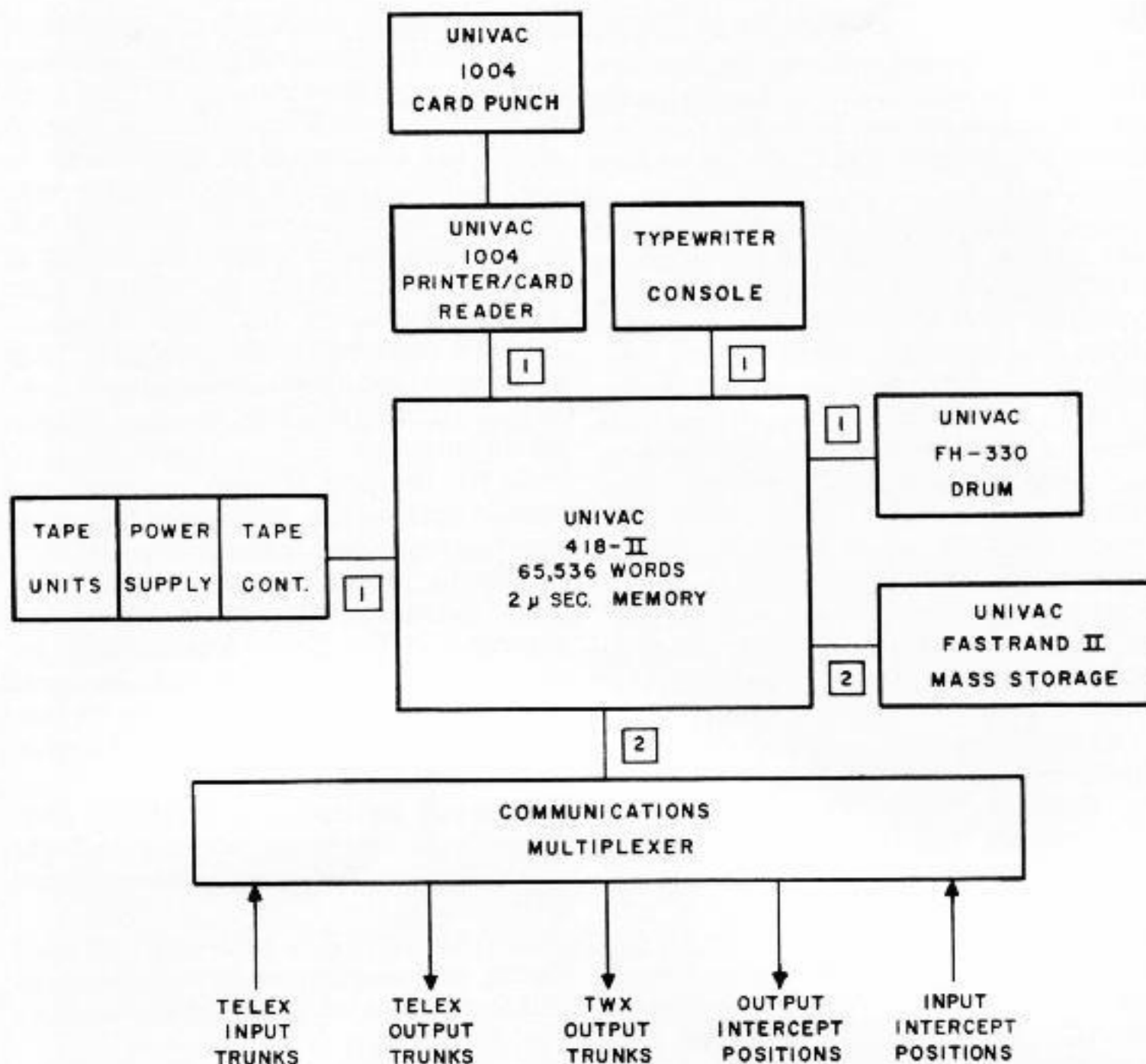
Figure 5, illustrates the number of units for a single system. In addition to these units, the computer center is also equipped with:

a. A Univac 1004 card punch is used during the preparation of the programs and to generate the charge to numbers for the Legal Citation Service.

b. A Univac Mass Storage drum, known as a Fastrand II is shown in Figure 6. This unit is capable of storing 44,040,192 (18 bit) computer words. Each group of 56 words can be accessed in an average of 92 milliseconds.

c. A bank of 6 transfer switches allow either tape sub-system, multiplexer, and FH-330 to be connected to either 418 computer. In addition, it connects the Fastrand unit to that computer handling on-line traffic. Each unit can be switched independently of any other unit, but only one tape system, multiplexer, or FH-330 can be connected to a computer at a time.

d. Twelve Telex interface units are used to convert normal Telex Baudot characters, to dial pulses for a Telex call. They also perform some of the signalling interfaces required between the computer and the Telex network.



Legend:
 □—number of
 Input/Output Channels
 required for one system

Figure 5. Interconnection Diagram of an On-Line System

e. Three Model 35 ASR sets, two Model 32 ASR Telex sets, and three Model 28 ASR sets with a printing perforator under the dome are equipped with answer-back capabilities. In addition three TWX Model 28 ASR sets are leased from AT&T under their tariffs. All these units are used by the

supervisory personnel to communicate with the users of the ISCC or to perform the TWX relay function.

f. Additional teletype equipment, interfaces, keypunches, etc. are used with the off-line system for testing and preparation of programs.

Expansion

During the latter part of 1966 and early 1967, the Information Services Computer System—Phase I (ISCS-I) will be cut over. This integrated system consisting of five Computer Centers with processors and concentrators tied together by high speed lines will cover the major industrial and business areas in the United States. The system will have a Univac 418 processor, another complete system for fall back and the 418 main frame as a concentrator in New York, Chicago and San Francisco. In Dallas and Atlanta only concentrators will be used.

The following service will be offered initially with this system:

- The ACTS services on a nationwide basis
- Mechanization of Tel(T)ex
- Legal Citation Service for Law Research Services, Inc.
- Private Shared Network Services
- Data Collection

This initial system will be the back bone upon which we can further expand and in later phases provide other inquiry, retrieval, transactions and data processing services, in addition to automating the Western Union public message handling system.

SERGIO WERNIKOFF, Director in the Information Systems and Services Department, has been responsible for the overall system engineering for the Information Service Computer Center.

He participated in the installation of the first Telex exchange and many Private Wire Systems. He was active in the planning of such projects as AUTODIN and the Advanced Record System for GSA.

Mr. Wernikoff received his degree in Electrical Engineering from Case Institute of Technology in 1957. He is a member of ACM, Association of Computer Machinery.



automatic test routiners

—F. John Zepecki

Automatic Test Routiners are used in Telex exchanges to provide automatic checking of major components and interconnections to detect equipment failures. The use of Automatic Test Routiners provides a periodic quality control check of every component in the Telex network. Their continued use is expected to optimize maintenance procedures, since maintenance personnel will be relieved of the task of routine checking. Thus, the faulty equipment can be repaired at the same time that other equipment is being checked by the Routiner.

Two types of Test Routiners are presently being tested, those for the CSR4 and the TWM2.

CSR4 Routiner

The CSR4 Routiner is designed to automatically test trunks to other Telex exchanges, subscriber's lines terminated on the CSR4, and subscriber lines of sub-district exchanges terminated on the CSR4. It checks for the proper operation of the switching equipment, as well as for signal distortion on the send and receive legs of the tested circuit. The Routiner may be programmed to test one circuit repeatedly, or to sequentially test each circuit in a group. In the Telex exchange, it appears as a combination of Register, RAL (Register Access to Link) Matrix, and Originating Link.

Test Procedure

Before the CSR4 Routiner can test, the following pre-test routine must be performed.

The Power switch is turned "On," and so is the On-Line switch which connects the

Routiner to the necessary exchange circuits. The circuitry is reset. The type of test and the number of the circuit are then selected by depressing one of three interlocking pushbuttons. The repetitive or sequential mode is selected by means of the Mode switch. The printer associated with the Routiner is turned on and the test is begun by depressing the printer Start button.

Trunk Test Sequence

In the trunk test sequence, the Routiner is programmed to test a particular trunk. It selects this trunk and "marks" its send leg to the distant exchange to request service. Upon receipt of a "proceed to select" pulse, the Routiner generates a special service code, which connects it to a special service trunk termination. This termination then loops the send and receive legs together as a "CALL CONNECT" signal. The Routiner generates a test signal which is looped back onto the trunk receive leg. The results of this test, including trunk identification and percent signal distortion are printed out on a teleprinter.

Upon completion of this sub-program, the Routiner sends a command signal to the special trunk termination causing it to open the trunk loop, and then connect a pulse generator to the trunk receive leg. The Routiner again measures for signal distortion, and prints out the test results. The connection is released.

If the Routiner has been programmed for sequential operation, it will seize the next trunk in the group and proceed to test it. But if the Routiner is programmed for repetitive operation, it will continue to seize and test the same trunk to facilitate the adjustment of the distortion level.

Local Line Test Sequence

In the local line test sequence, the Routiner can test either local (current-no current loop) or long distance ($\pm 120V$ polar) subscribers. The Routiner is first programmed to select a subscriber line. Upon establishing a connection, the Routiner transmits an undistorted "FIGS D" (who-are-you) signal to the subscriber, tripping his automatic answer back. A printout is provided on the associated teleprinter for a signal distortion of more than 5 percent. Upon completion of this sub-program, the Routiner transmits a "FIGS D" signal at distortions of 25 percent and 35 percent. Each time it checks for an answer back. And if none is received, a printout is sent to the associated teleprinter indicating that no answer back was received. The Routiner then disconnects the call.

The test will be repeated for the same line if the Routiner is in the repeat mode. If it is in the sequential mode, it will proceed to the next line in the group.

Remote Line Test

In the remote line test sequence, the Routiner is programmed to select a distant subscriber line. However, in this case, a trunk number must also be included. The Routiner will seize this trunk and transmit the selected subscriber's code digits. When connection to the subscriber is made, the test routine will be the same as the local lines test. The results of this test, in addition to the results of the test on the trunk being used, determine the quality of the remote subscriber's circuit.

TWM2 Routiner

The TWM2 Routiner is designed to automatically test outgoing trunk circuits to other exchanges which are equipped with special test terminations, and the Final Selector and subscriber circuits of the TWM2 exchange. The Routiner checks for the proper operation of the switching equipment as well as for excessive signal distortion on the send or receive legs of the circuit under test. It accesses the trunk via the Repeater racks and accesses the subscriber lines via the Final Selector

racks. These racks are wired to the Routiner. If ten consecutive faults occur in the course of a test, an alarm will be sounded.

At the beginning of each test sequence, the Routiner is programmed by depressing the pushbuttons on the control panel. Buttons are provided to select the type and group of circuits to be tested, and to connect the Routiner to these circuits. Additional controls are provided to set up a test manually, to start a test immediately or with a time delay, and to cause a test to repeat. A reset button is also provided to cancel a test program at any point.

Trunk Test Sequence

In the trunk test sequence, the Routiner attempts to seize a selected outgoing or two-way repeater in the outgoing direction. If it is unable to do so, it will wait $1\frac{1}{2}$ minutes and again attempt seizure. If it is still unable to do so, the fault printout (-00-) will be sent to the associated teleprinter. After the repeater is seized, the Routiner checks for the confirmation pulse (first revertive pulse) and the "Proceed-to-select" pulse (the second revertive pulse), if the trunk is connected to another junction office. Failure to receive the first pulse will result in fault printout (-01-), while failure to receive the second pulse will yield the fault printout (-02-).

Upon receipt of these pulses, the Routiner generates the dial code of the special test termination in the distant exchange. If the Routiner is checking a trunk to another TWM2 exchange, the test termination would be that exchange's Routiner. If a busy signal is received during or after dialing, a fault code (-03-) is generated and the Routiner will hold the trunk connection for four to five minutes while trying to seize the distant test equipment. If no connection is established in 5 minutes, an alarm is sounded to indicate a fault in the distant exchanges termination.

When a connection is established, the Routiner transmits a test signal which is analyzed by the distant test equipment, to determine if the distortion exceeds the allowable limit. If it does, the fault code (-04-) is printed out on the associated

printer. When this sub-program is completed, the Routiner transmits a command signal to the distant office test termination to generate a test signal. The distortion level of this signal is determined by the Routiner and if it exceeds the allowable limit, the fault code (-05-) is printed.

The connection is broken by the Routiner and the printout of fault code (-06-) indicates an inability to disconnect. If the repeater under test returns to the idle state and is available for seizure too soon after the disconnect, fault code (-07-) is printed out.

A final check is made to assure that the repeater's seize wire has been opened. If it has not been opened, the code (-08-) is generated. Upon completion of the test, the Routiner steps to the next repeater and reinitiates the test sequence.

Line Test Sequence

In the line test sequence, the Routiner attempts to seize a specified Final Selector. If it is busy, the code (-++-00) is generated, but if it is idle and cannot be seized the fault code (-++-01) is printed out. When it is seized, the Final Selector tries to seize a Marker unit. If it is unable to do so, or if the connection is improperly made, the fault code (-++-02) is generated.

If the subscriber is busy, the code (-XX-00) is generated and the Final Selector is stepped to the next subscriber. The code digits (-XX-) are the dial digits

of the selected subscriber. When an idle subscriber is selected, a connect signal is transmitted, but if his teleprinter does not turn on, the fault code (-XX-03) is printed out. When the connection is established, the subscriber is sent an information code to tell him that a test will be performed on his equipment. During the transmission of this message, the subscriber's send leg is monitored. If there are voltage fluctuations on his send leg, the fault code (-XX-04) is printed out on an associated teleprinter. Then, the characters "FIGS D" (who-are-you) are transmitted to the subscriber with a preset amount of signal distortion. A check is made to assure that his answer back has been received. If it has not, the fault code (-XX-05) or (-XX-07) is generated to indicate an excessive amount of distortion. The subscriber's answer back signals are checked for distortion and the fault code (-XX-06) or (-XX-08) is printed out when the distortion level is too high. The Routiner then releases the connection.

If the subscriber's circuit does not return to the idle state, the fault code (-XX-09) is generated. Upon release, the Routiner reseizes the Final Selector and proceeds with the test of the next subscriber in the group. The same Final Selector is used to test four subscriber circuits, before the Routiner releases it and seizes the next Final Selector on the rack.



F. JOHN ZEPECKI is an Engineer in the Telex Section of the Information Systems and Services Department. Since joining Western Union in June 1964, Mr. Zepecki has been engaged in the development and testing of equipment for use in Telex exchanges and outstations. His work has included the design and testing of the Telex TW56 Concentrator Test Set, and a solid state Metering Pulse Generator for Telex exchanges.

Mr. Zepecki received his degree of Bachelor of Engineering from Stevens Institute of Technology in 1964, and is presently working toward his Masters degree in Electrical Engineering at Newark College of Engineering.

patents
recently issued
to
western union

Assignee

H. J. Goonan and
J. K. Fitzpatrick

H. C. Likel

Robert Steeneck

P. F. J. Recca

William V. Johnson and
George A. Tompkins, Jr.

R. Steeneck

R. C. Taylor and
F. L. O'Brien

Patent

3,194,467
Waveguide Flanging System

3,215,946
Series Energized
Transistorized Circuit for
Amplifying and Inverting
Polar Input Signals

3,225,331
Diode Matrix for
Decoding Pulse Signals

3,232,604
Card Feed Mechanism

3,235,197
Motor Driven Tape Scanner
and Rewinder

3,242,385
Universal Network Assemblage

3,251,005
Transistor Stabilized Oscillator
with Tapped Coil

CSR4

exchange

—James S. Chin and Jan J. Gomeran

The Communications Switching Reed Exchange is a common control automatic switching system utilizing matrices as switching stages. The common control type switching system implies that the input and output terminations are identified and seized before the transmission path between them is set up.

To increase the traffic capacity of the present Telex System, a new type of switching center, called the Communications Switching Reed Exchange CSR4, is being installed in various cities within the United States.

The design of the network allows it to be installed as either a high echelon junction office or a low echelon district office, without any change in major equipment.

The switching center is laid out in terms of register groups. Each register group is required to handle a corresponding number of line, link, trunk, sender and receiver groups. A register group contains a maximum of 28 registers and serves one line, one link and one trunk group.

The CSR4 system is capable of handling four types of calls: line originating to line terminating, line originating to trunk terminating, trunk originating to line terminating, and trunk originating to trunk terminating. The line calls are "local" subscribers' calls which are terminated directly on this exchange. The trunk calls are calls received from or destined to "remote" subscribers, terminated on other exchanges.

The CSR4 exchange contains two types of switch matrix; the directional matrix and the concentration matrix. The directional matrix is the heart of the switching section. All calls through the exchange have to be routed through this matrix net-

work. The input terminals appear on the "J" or left side of the matrix while the output terminals are on the "L" or right side of the switch. The concentration matrix provides the connecting paths between "local" subscribers and a limited number of link circuits.

The processing of each call requires the following four major steps:

- 1) Originating connection
- 2) Digit evaluation
- 3) Terminating connection
- 4) Register control

The basic units used to process calls through the CSR4 exchange are shown in the block diagram in Figure 1.

Originating Connection

For each originating call, an incoming trunk or line circuit is connected to a register. For a trunk call, the path selector is responsible for this connection, while for a line call the marker is responsible.

On a trunk originating call, the request is sensed by the path selector over path #16, as shown in Figure 1. The path selector immediately scans all originating trunk groups and seizes the requesting trunk. Next, it scans the register group serving this trunk group and seizes an idle unit. The scanning and selection process will be explained further in another section of this

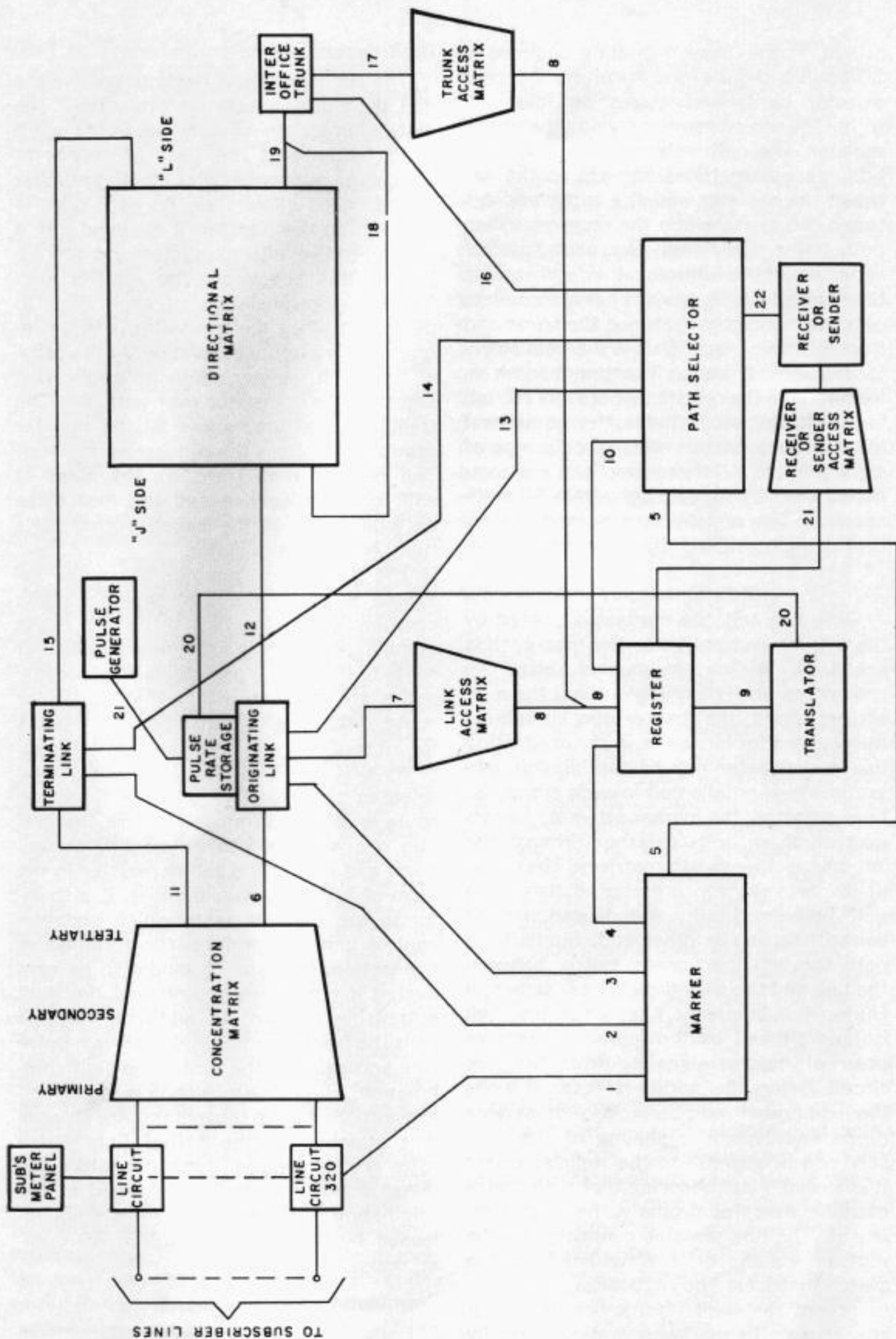


Figure 1. Block Diagram of CSR4 Exchange

article. If the trunk signaling requires a 50 baud two-out-of-five receiver, the path selector hunts and seizes an idle unit within the receiver group serving the seized register. The path selector then examines both access matrices for idle paths between the register and the trunk and between the register and the receiver. When both paths are found, the path selector connects all the units together and verifies the connection. If a receiver is not needed, only the connection between the trunk and the register is made. Before the path selector releases, it feeds all pertinent trunk information to the register, where it is stored. This information includes the equipment identity number, the class of call, type of signaling, etc. All these functions are completed by the path selector within 80 milliseconds. The register is now ready to accept the subscriber's digits from the trunk.

On a line call, the request is sensed by the marker over path #1. The marker then scans all the line groups and seizes the requesting line. Having identified the subscriber group, the marker now simultaneously scans for idle units in the originating link and register groups serving this line group. When an idle unit in each group has been selected, the marker attempts to connect all three units together through the interconnecting switch matrices. The marker inspects the concentration matrix for a path between the line on one end and the seized link on the other end. Similarly, a path through the access matrix between the link and the seized register is selected. During this sequence, the originating link is programmed by the marker to receive polar or neutral signaling from the line circuit. Before the marker releases, it feeds the equipment number, class of service digits and type of signaling of the subscriber's line circuit to the register where it is stored. After checking that both matrices have operated properly, the marker releases. The line remains connected to the register via the originating link and the switch matrices. The register is now ready to accept the digit information from the subscriber. The marker operation normally takes 100 milliseconds.

Digit Evaluation

The register is now ready to receive the dial digit information for evaluation. The dial information, usually seven or eight digits, represents the class of service of the calling subscriber and the dial number of the called subscriber. As each digit is pulsed into the register, it is coded into a two-out-of-five bits character and stored. During this sequence, the register performs a pretranslation of each digit to determine when the translator is to be requested for a route evaluation. At the proper time, the register sends an application signal to the translator over path #9. The translator, in turn, scans all the register groups and seizes the requesting register. The register then transfers the class of call, class of service and the first three or four digits of the called subscriber's number to the translator.

The translator examines all routes assigned to either the first two dial digits combination or the first three dial digits combination. Before assigning a particular route to the call, it ascertains whether idle paths are present within that particular route at the time of translation. If all paths for all routes are in use, the translator returns a "busy" signal to the register and releases the register. If more than one route is idle, the translator picks the first idle one according to its priority assignment and presents it to the register in the form of a trunk group number. It also informs the register as to which common control unit will perform the terminating connection, the type of sender to be connected if one is necessary, and the digit outputting pattern. In addition, for line calls the translator also determines a pulse rate according to the first three-digit combination. The pulse rate code is fed directly over path #20 to the meter pulse storage unit attached to the seized link. Pulse rates are not required for trunk calls since this function is usually performed at the originating exchange. The register is released by the translator within 80 milliseconds.

Terminating Connection

Using the decoded information from the translator, the register decides whether

there is enough dial digit information already received to effect a terminating connection with the chosen common control unit. For a line terminating connection, all the digits have to be received before the connection can be completed by the marker and path selector. If the connection is trunk terminating, the number of digits required before the path selector performs its functions depends on the type of sender needed to output the digits to the next office. The 50 baud sender requires that all but one digit be received before a connection can be made. The dial pulse sender requires an immediate connection. This is to reduce the holding time of the units to a minimum since a limited number of each type is being shared by all trunk groups.

On a line terminating connection, the register requests the marker and the marker scans the register groups and seizes the requesting register. The seized register sends the marker the called subscriber's equipment number, which is usually the last four digits of the dial digit number, and the calling subscriber's class of service digits. The marker hunts for and selects the desired line circuit, checks for an idle condition, and compares the called and calling subscribers' class of service digits for compatibility before proceeding to set up the connection. It next seizes an idle terminating link serving this line group and locates a path through the associated concentration matrix between the called line circuit and the terminating link. Simultaneously, the marker requests the path selector for a connection through the directional matrix between the terminating link and the originating link or incoming trunk. When both paths have been found, the marker completes the connection and releases. The connection is left under the control of the register.

On a trunk terminating connection, the register requests the path selector and sends it a two-digit route identification plus the type of sender and outputting pattern required. The path selector deciphers the trunk group and picks an idle trunk within this group. It also selects the proper sender and then proceeds to locate paths through the directional and sender access

matrices. Once this is done, the path selector releases leaving the connection under the control of the register.

Register Control

After the transmission path is established through the office, the register takes over the control of each call and insures that the call is completed to the called subscriber. For the line terminating sequence, the register monitors the circuits, to insure that both subscribers are connected properly, before releasing. For the trunk sequence, the register checks the circuits to the other office and sends forth the necessary dial information to complete the connection to the remote subscriber. If a busy condition is encountered, the register sends a busy signal back to the calling subscriber and proceeds to knock down the connection.

Scanning and Selection Process

Scanning of the common control equipment is similar for links, trunks, senders and receivers but it varies slightly for lines and registers.

Links, trunks, senders and receivers are selected by using a four-step scanning process. These steps are group selection, cabinet selection, subrack selection and position selection. Lines are chosen by scanning the thousands, hundreds, tens and units digits, respectively. Registers are scanned first by groups then by subracks and lastly by cabinets. The common control equipment uses memory units to distribute selection as evenly as possible. The scanning is inhibited when the associated register group is busy.

Links

Each link group consists of a maximum of 12 cabinets or racks. Six of these cabinets contain originating links and the other six contain terminating links. The originating links and terminating links are scanned at different times.

The proper link group is determined from the calling line identity in the case of an originating link group and from the called line identity in the case of a terminating link group. Then one of six cabinets

within this link group is chosen. A link cabinet consists of three link subracks and these are scanned next. After a subrack is selected, one of ten positions in this subrack is chosen. If blocking is encountered in the concentrator switch, a second attempt is made by the marker to connect up the line to another link position.

Trunks

An incoming trunk group consists of a maximum of 3 cabinets. Each cabinet contains 6 subracks. An outgoing trunk group can have up to 2 trunk group relays assigned to it. Since each trunk group relay has 3 contacts, the maximum number of subracks in an outgoing trunk group is 6. Each trunk subrack can hold up to 15 trunks. First, the group is selected and then the subrack and position are chosen.

Senders and Receivers

There are 16 senders or receivers and 6 senders or receivers per subrack. First the type of sender or receiver is chosen. Then a subrack containing this type is picked followed by the selection of the actual unit.

Lines

A line group consists of 960 lines. Lines are scanned in the following sequence: Groups, hundreds, tens, and units digits.

Registers

One out of a maximum of twelve register groups is chosen first. There are six cabinets per group and five subracks (each one representing an individual register) per cabinet. A particular subrack position in each of the six cabinets is chosen first and then one of the six cabinets in the group is selected.

Components of CSR4

The following is a brief description of the major units comprising the CSR4 exchange.

Marker

The marker is a common control unit used to set up calls to the "local" sub-

scribers through the proper concentration matrix. Since each matrix is limited to a maximum number of 320 "local" subscribers, more than one matrix switch may be used. To find the proper matrix, the marker using the selection process described above, pinpoints the subscriber's line circuit and its associated link unit. Then with the proper polarities applied on both the line side and the link side, the marker examines all the matrices and selects the one with the applied voltages. A similar process is carried through for terminating calls. The marker also programs the links to handle the particular type of line signaling that the subscriber is using. A special feature of the marker enables calls, destined for heavily loaded circuits, to be switched to special trunks set up to handle the heavy load. This helps to maintain the 1 percent grade of service offered to Telex subscribers. During the busy hour the marker is capable of handling 18,000 calls per hour.

Path Selector

The path selector handles three types of requests. These requests originate from either an incoming trunk, a register or a marker. On an incoming trunk request, the path selector connects the trunk to a register and the proper receiver (if needed) to this register via register access matrices. On a register request, the path selector connects an originating link or incoming trunk to an outgoing trunk via the directional matrix. If a sender is required, the path selector connects the proper one to the register via a register access matrix. On a marker request, the path selector is needed for either a terminating link call or a special service call. On a terminating link call, the path selector connects a terminating link to an originating link or incoming trunk via the directional matrix. On a special service call, the path selector connects an originating link or incoming trunk to a special service trunk via the directional matrix.

An important characteristic of the path selector is one which prevents faulty first-choice trunks from blocking a trunk group in light traffic. In periods of low usage, a memory unit is employed in the

trunk selection process to alternate the first choice trunks.

A traffic limitation imposed on the path selector is that the maximum number of applications for the path selector per busy hour cannot exceed 18,000.

Translator

The translator analyzes the first two or three digits of the called subscriber's number and examines simultaneously all the routes assigned to this digit combination. The route can be made busy for other reasons than total occupancy of the trunk. These include "class of service" and "class of call" restrictions. For a call destined to another office, the translator assigns the outpulsing pattern of the digits being sent to the next office and selects the type of sender to be used. For zoning purposes the translator evaluates the first three digits and chooses the assigned pulse rate.

Register

The register receives information from either a subscriber in its own exchange or a register in a distant exchange. When receiving from a subscriber, it is accessed from an originating link via a register access matrix. When receiving from a distant office register, the register is accessed from an incoming trunk via a register access matrix.

The register sends a 25 millisecond revertive pulse to indicate that it is ready to receive digits from a distant office. The register is equipped with a dial pulse receiver. In order to receive 50 baud (2-out-of-5) signals from ITT offices, a separate receiver is attached to the register by the path selector. The register has the capacity of storing up to ten digits.

An important characteristic of the register is its capability of generating its own class of service when processing calls from non-ITT offices. The fixed number assigned indicates that the calling party is a 50 baud Telex subscriber.

Links

Line originating calls utilize an originating link and line terminating calls use a terminating link.

The originating link interfaces with the concentration matrix, the directional matrix and a register access matrix. This gives it access to line circuits, trunk circuits and registers. It repeats the signals from the concentration and directional matrices to the register. The subscribers appearing on the line side of the concentration matrix may use either loop or polar operation but the originating link provides only polar operation out to the trunk side of the directional matrix. In the call-connected condition, the originating link recognizes a disconnect signal from either party and proceeds to remove the potential holding the concentration matrix. The originating link is also responsible for sending meter pulses to the calling subscriber's meter.

The terminating link has access to lines and trunks via the concentration and directional matrices. Like the originating link, it converts loop or polar subscribers to polar operation. It is responsible for applying the hold potential to both the concentration and the directional matrices. In the call-connected condition, the terminating link does not itself recognize subscriber termination of a call. The incoming circuit detects the disconnect signal and opens its signaling wires. This is detected by the terminating link which then removes the hold potential from the concentration and directional matrices.

Senders and Receivers

The office works with dial pulse and 50 baud, 2:5 senders and with a 50 baud, 2:5 receiver. The path selector connects these units to the register through register access matrices.

The dial pulse sender is used to forward address information to non-ITT offices. It converts the 2:5 digits received from the register to a 1:10 code and sends them to the distant exchange in dial pulse trains.

The 50 baud, 2:5 sender is used to forward address information to the other ITT offices. It accepts one digit at a time in 2:5 from the register and transmits to the distant office in 2:5 at 50 baud in an eight-element code. This code consists of the following: START, 0,1,2,4,7,STOP, STOP.

The 50 baud, 2:5 receiver is connected to the register when addressing data is be-

ing received from an ITT office. It accepts one digit at a time, serially, consisting of eight bits in the following order: START, 0, 1, 2, 4, 7, STOP, STOP. These data bits are transferred in parallel, on a five-wire bus to the register via the register receiver matrix.

Trunks

The trunk circuits provide the interface between the carrier equipment and the switching equipment. They use polar signaling and are capable of two-way operation.

In the incoming mode, the trunk appears on the J side of the directional matrix. It is connected to the register via the register access matrix in response to a seizure by a distant office trunk. In the outgoing mode, the trunk appears on the L side of the directional matrix and provides

concentration type. The distributional matrix implies that there are an equal number of input and output terminals. The concentration matrix implies that a certain number of inputs are reduced through "grading" to provide a smaller number of outputs. The "grading" of each matrix depends on the traffic capacity and where it is used. In the CSR4, the directional matrix represents the distributional type while the other matrices are of the concentration type.

The directional matrix can be either a 3-stage or a 5-stage network depending on the maximum number of inputs needed. If more than 200 terminations are needed the 5-stage network is used. The exact layout of the matrix switch is quite involved; however, a simplified layout of a 9-input, 3-stage matrix is shown in Figure 2. The 5-stage matrix can be considered a 3-stage

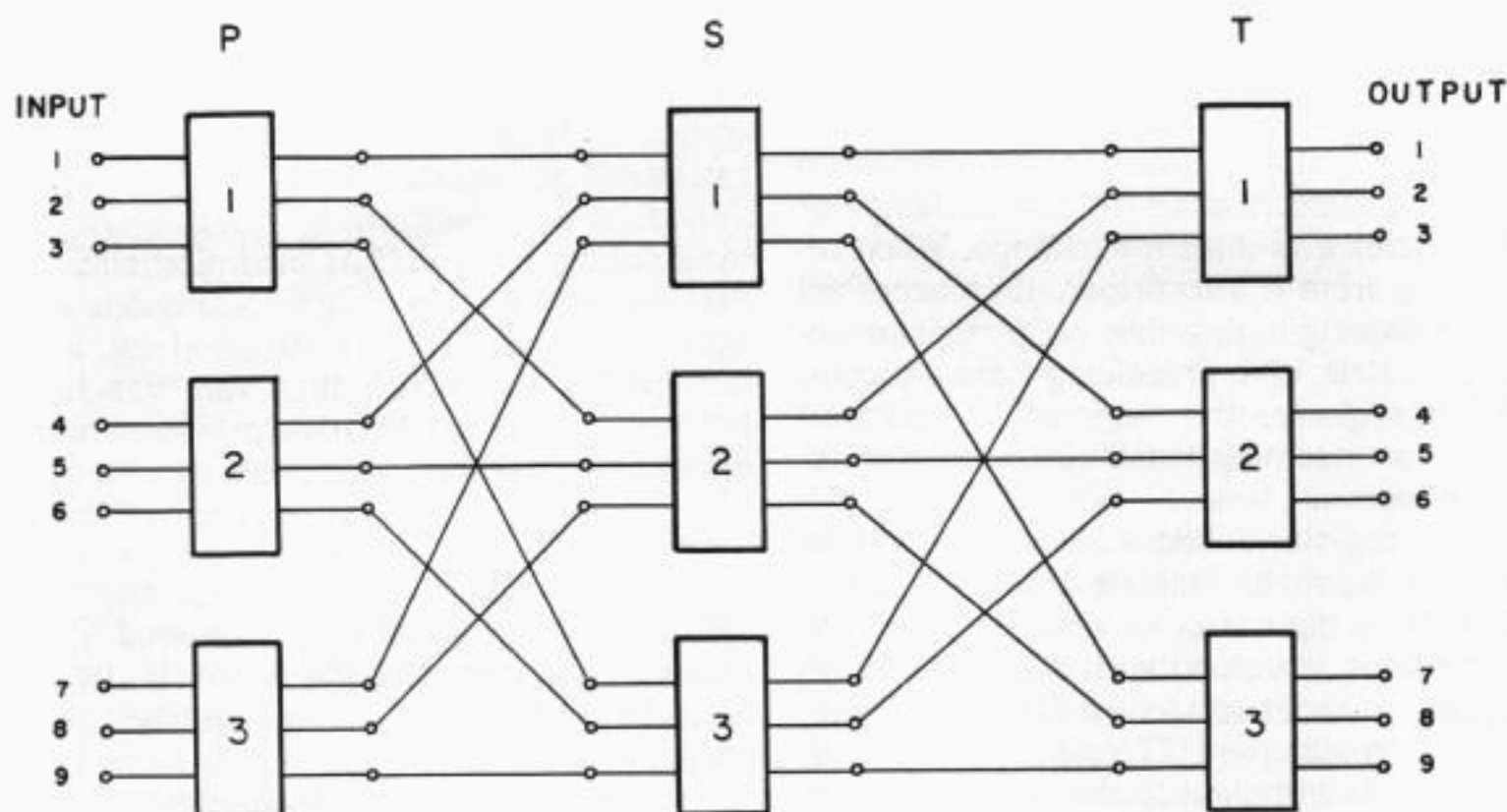


Figure 2. Simplified Layout of a 3-Stage Matrix

the forward seize signal to attach the next office in the routing sequence.

When in the call-connected condition, the outgoing trunk is responsible for holding the directional matrix; but the signal to release the matrix comes from the incoming trunk or originating link.

Matrices

There are two types of matrices used in the system: the distributional type and the

network with the center stage a 3-stage matrix in itself rather than a single stage.

The concentration and access matrices are of the 3-stage variety with the "grading" being done between the primary and secondary stages.

Figure 2 illustrates the many possible paths between the input and output terminals. Any one input is fanned out through the primary (P) stage to each secondary (S) stage, which in turn branches out

through each tertiary (T) stage to a particular output. As the size and number of each matrix increases, the combinations of paths increases geometrically, and thus provides a very low percentage of blocking.

The basic building block of the directional and concentration matrices is a 5 by 5 array of reed relays while the access matrices are made up of 4 by 4 arrays.

Line Circuits

The line circuit provides an interface between the subscriber's lines and the exchange. It can be strapped to accept either polar or neutral signaling. The line circuit notifies the marker whenever a subscriber requests service. If a fault condition exists on the subscriber's lines, the line circuit goes into a lockout condition which isolates the subscriber from the exchange until the trouble is cleared up.

Special Features of the CSR4 System

The CSR4 system has several unique features.

- Multiple alternate routing
- Full accessibility of all trunks
- Fault printouts from major common control units to identify trouble
- Class of service restriction
- Narrowband and/or wideband transmission
- Optional dial pulse or keyboard signaling
- Modular construction

JAMES S. CHIN, Project Engineer in the Information Systems and Services Department, is responsible for the system testing and installation of the new Telex exchanges for the expanded Telex System.

He joined Western Union in 1960 and has been engaged in designing and installing test equipment for the Telex exchanges.

Mr. Chin received his B.E.E. degree from Rensselaer Polytechnic Institute in 1959.



JAN J. GOMERMAN, an Engineer in the Telex Section of the Information Systems and Services Department, has been responsible for various design changes in the TWM2 Telex exchange. He is presently concerned with the acceptance and installation of the CSR4 exchange.

He joined Western Union in 1964, after receiving a B.E.E. degree from the City College of New York. He is currently studying for a Masters degree in Electrical Engineering at New York University.



Telex
Switching Systems
Circuit Switching
Line Switching

Wunner, John J., Jr.: Telex Switching System TWK4

Western Union TECHNICAL REVIEW, Vol. 20, No. 3 (July 1966)
pp. 96-104

This article describes a new type Automatic Teleprinter Exchange, which is in the Telex system at the sub-district level, and is connected to a district or junction office via a trunk line group.

Telex
Monitors
System Maintenance
Test Facilities
Display Device

Feldman, Melvyn M.: Pulse Rate Monitor

Western Union TECHNICAL REVIEW, Vol. 20, No. 3 (July 1966)
pp. 106-107

Western Union has developed a Pulse Generator Rate Monitor. This article describes that monitor, which checks the pulse generator outputs and electronically samples pulses sent via the pulse generator. When various fault conditions are detected, an office alarm condition occurs.

Telex
Subscriber Terminals
Data Communications
Terminal Equipment

Lavitola, Peter J.: Outstation Options

Western Union TECHNICAL REVIEW, Vol. 20, No. 3 (July 1966)
pp. 108-111

In order to meet the data communication needs of its customers, Western Union offers the following options in Telex: Control of Auxiliary Devices; Tape Transmitter Control; and Automatic Dialer. This paper outlines each of those options.

Telex
Traffic Evaluation
Traffic Load
Instruments

Panzaru, Emil: Traffic Recording Methods

Western Union TECHNICAL REVIEW, Vol. 20, No. 3 (July 1966)
pp. 112-119

At Western Union, Erlangmeters, Traffic Recorders and 12-Value Integrators are used to study Telex traffic volume. This article describes the methods and instruments used.

SERVICE TO OUR READERS:

As a service to our readers, articles will be abstracted so that a complete file may be kept for future reference.

Telex

Computer Techniques
Data Switching
Switching System
Devices

Mansfield, Earl C.: Telex Interface

Western Union TECHNICAL REVIEW, Vol. 20, No. 3 (July 1966)
pp. 120-127

The Telex Interface, as described in this paper, not only permits the computer to initiate calls to Telex subscribers, but also allows subscribers to send messages to the computer.

Telex

Computers
Public Services
Message Switching

Wernikoff, Sergio: Information Services Computer Center

Western Union TECHNICAL REVIEW, Vol. 20, No. 3 (July 1966)
pp. 128-137

This article describes the services offered in the Western Union Information Services Computer Center, which is the first development in the ultimate integration of computerized Telex with the Public Message services.

Telex

Test Instruments
System Maintenance
Quality Control

Zepecki, F. John: Automatic Test Routers

Western Union TECHNICAL REVIEW, Vol. 20, No. 3 (July 1966)
pp. 138-140

Automatic Test Routers provide a periodic quality control check of every component in a Telex network. The two types of Test Routers, CSR4 and TWM2, are described in this article.

Telex

Switching Systems
Circuit Switching
Line Switching

Chin, James S. and Jan J. Gomeran: CSR4 Exchange

Western Union TECHNICAL REVIEW, Vol. 20, No. 3 (July 1966)
pp. 142-149

This article describes the Communications Switch Reed exchange, which is Western Union's new type of switching center in the Telex system. This type of exchange is being used at the Junction and District levels.

experience ***and*** ***teamwork***

A solid record of experience in planning, designing, and engineering, the Western Union's Telex system coupled with the experience in testing, installation, and maintenance of it is documented in this special issue of Telex. The teamwork exemplified by the authors is testimony to our unique position in the field.

Projects like the CSR4 and TWK4 exchanges, the Information Services Computer Center, and various interfaces require experience and ingenuity to be successful. CSR4, Communications Switch Reed Exchange, was prompted by the need for a more universal exchange type in our present Telex network. The new TWK4 exchanges envision expansion of our exchange terminal facilities from 50 to 200 subscribers per unit. Our new Information Services Computer Center, ISCC, integrates our growing public services with our computerized Telex operation. The Telex interface units permit subscribers to send messages to the computer and also allows the computer to initiate calls to Telex subscribers.

Our engineers are constantly seeking the right answers to communications problems. This know-how is based on many years of experience plus the ability to evaluate new equipment for our Telex subscribers. The dedicated teamwork of our Telex group has helped immeasurably to produce the reliable information systems and services we proudly present today.



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